OPHTHALMIC AND OTIC MEMORANDA.

Carroll Dunham Jr.
Irvington on Hudson
Westchester County
New York.

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Irvington-on-Hudson.
New York.

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PREFACE.

The little book that is herewith presented to students and practitioners of medicine has been prepared with great care. It aims to give a concise and correct outline of our present knowledge of Ophthalmology and Otology, and to serve as a kind of Dictionary of these subjects. We shall be sorry if it is ever used to acquire a *primary* knowledge of either of these sciences, or if it is trusted for *complete* directions as to the diagnosis and treatment of ophthalmic and aural diseases. The anatomical portions, however, will be found quite as complete as in any one book in our language; as we have made a systematic grouping of what has hitherto been found only by consulting several works in English, German, and French. We believe our book will prove especially useful to those who are attending lectures upon the subjects of which it treats, but who are too busy during the lecture-season to consult the larger treatises. We hope, also, that even experienced general practi-

tioners and specialists will find it a trustworthy aid to the memory, in recalling facts which sometimes escape the minds of the most learned.

In endeavoring to make the book as small as possible, we have made the text very concise, but we trust there has been no sacrifice of clearness on that account. The treatment recommended for the different diseases is that which has been found generally efficacious, or which has been suggested by a not inconsiderable personal experience in public and private practice. Points regarded as still unsettled are indicated by interrogation-marks. The derivations of nearly all technical terms have been given with the words themselves, as they occur in the text ; and for greater convenience an alphabetical list of them has also been placed at the end of the book. Where the derivation is doubtful, it is followed by an interrogation-point. Wherever the name of a person prominent in Ophthalmology or Otology occurs, it is followed by his country and century in brackets.

The following abbreviations have been used:—*Gr.* for *Greek; Lat.* for *Latin; Lat. equiv.* for *Latin equivalent; Ant.* for *anterior; Post.* for *posterior; O.* for *origin; I.* for *insertion.*

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PART I.

OPHTHALMIC MEMORANDA.

CHAPTER I.

THE ANATOMY AND PHYSIOLOGY OF THE EYE.

THE visual apparatus consists of the eyeballs and their accessory parts for collecting luminous impressions, and the optic nerves for conveying them to the brain. Each eyeball contains a special nervous membrane—the *retina*—capable of appreciating both the intensity of light and its color. By passing through the cornea and lens the rays of light are focused upon the retina and inverted images of external objects are formed there—the layer of rods and cones being considered the perceptive layer. These impressions are conveyed to the brain by the optic nerves and thence projected outward erect. The projected image corresponds to the object, and we say that we *see* the object, although we really see only its image. The amount of light admitted to the eye is regulated by the reflex movements of the iris—the pupil contracting in a bright light and dilating in a

feeble one. The eye possesses the faculty of *accommodation*,—that is, of adjusting itself for vision at different distances, so that the focus of the rays of light is kept in the retina alike when we look at a far-off landscape or read a book. Only a small part of an object can be seen *distinctly* at any one time, the surrounding parts being more or less blurred; on the other hand, the eye is so rotated by its muscles as to command a very extensive field. The two eyes act in perfect harmony, and the images being symmetrically disposed on the two retinæ are combined into a single impression. The two retinal images are slightly different (each eye seeing its corresponding half of the object most distinctly), and from their union result our ideas of *solidity*. Our ideas of *distance* are derived from the efforts at convergence required to see distinctly and from experience. The manner in which the brain produces a single erect image from the two inverted retinal images has not been satisfactorily explained.

ORBITS.

Bony cavities in which the eyeballs are securely contained. Shaped like four-sided pyramids, bases pointing forward and outward, apices backward and inward. About $1\frac{4}{5}$ inches deep. Axes inclined to each other at angle 42°–43°. Each orbit formed from

seven bones: frontal, sphenoid, ethmoid, superior maxillary, palate, malar and lachrymal, three former being common to both orbits. ROOF formed by frontal and sphenoid; very thin; separates orbit from cranial cavity and frontal sinus; fossa for lachrymal gland at outer, anterior angle; depression (*fovea trochlearis*) for pulley of superior oblique muscle at inner angle. FLOOR, by superior maxillary, malar and palate bones; near centre, *infra-orbital groove* running from behind forward, converted into canal which opens on face $\frac{1}{6}$ inch below orbital margin, transmits infra-orbital vessels and nerve. INNER WALL, by superior maxillary, ethmoid, sphenoid and lachrymal bones; very thin, $\frac{1}{1}$–$\frac{1}{64}$ in.; anteriorly has *lachrymal groove* (for lachrymal sac) bounded in front and behind by *anterior* and *posterior lachrymal crests*. OUTER WALL, by malar and sphenoid; thickest ($\frac{1}{18}$–$\frac{1}{12}$ in.); presents *zygomatico-temporal* and *zygomatico-facial* (or *malar*) *foramina* for nerves of same name. In suture between inner wall and roof are *ant.* and *post. ethmoidal* foramina for ethmoidal vessels and nasal nerve. Between roof and outer wall posteriorly is *sphenoidal fissure* for 3d, 4th, ophthalmic division of 5th, 6th nerves, and ophthalmic vein. Between floor and outer wall posteriorly is *spheno-maxillary fissure* for infra-orbital vessels and nerve and ascending branches from sphe-

no-palatine ganglion. BASE, facial opening of orbit $1\frac{3}{5}$ in. wide, $1\frac{1}{3}$ in. high; has strong bony edge, pierced above, about one inch from median line, by *supra-orbital notch* (or *foramen*) for supra-orbital vessels and nerve; bases $\frac{3}{4}$ in. apart. APEX, formed by optic foramen and canal; canal funnel-shaped, runs between two roots of lesser wing sphenoid, backward, upward and inward to middle fossa of skull; $\frac{1}{5}$ in. long, $\frac{1}{4}$ in. calibre; transmits optic nerve and ophthalmic artery. Orbits lined by periosteum (or *periorbita*) continuous at fissures and sutures with that of facial bones and with dura-mater; forms tendinous ring about optic foramen, giving origin to ocular muscles. Upon periosteum is layer connective tissue and fat, forming cushion for eyeball; connective tissue thickened to form sheaths for muscles, vessels and nerves, and fasciæ for connecting different parts within orbit with each other and with periosteum. Such fasciæ connect cartilages of lids with edge of orbit and with capsule of globe and surround muscles of eye with funnel-like sheath. One, starting from optic foramen, surrounds optic nerve, then spreads over eyeball, *tunica vaginalis bulbi*, and is lost anteriorly on sclerotic; is pierced by tendons of muscles, with which it is connected; posterior part loosely attached, allowing eyeball to rotate in it, called *Bonnet's capsule;* part anterior to passage of

tendons called *Tenon's capsule.* Rudimentary organic muscles found in orbit—*external, internal* and *inferior orbital :* supposed to strengthen union of lids with orbit; inferior, largest, $\frac{1}{25}$ inch thick, covers inf. orbital fissure.

OPTIC NERVES.

Origin in *thalami optici* and *corpora quadrigemina*, receiving filaments from *corpora geniculata, tuber cinereum, lamina cinerea, ant. perforated space, gray substance of brain, and post. columns spinal cord.* Fibres run forward, as *optic tracts*, beneath thalami and across crura to front of infundibulum, where they unite to form *optic chiasm* [Gr. χιασμα, *the figure* χ] in which they decussate. Chiasm rests on olivary process, sphenoid bone. From inner end each tract fibres cross to nerve of opposite side, and supply inner half opposite retina. Greater part run directly, without crossing, to outer half retina of same side. On ant. edge of chiasm fibres run from one nerve to other—*ant. commissura arcuata*, or *inter-retinal fibres.* On post. edge fibres run from one tract to other—*post. commissura arcuata*, or *inter-cerebral fibres.** Vessels of tract and chiasm from pia-mater and brain. *Optic nerves* proper start from lateral portions chiasm, run divergent to optic foramina, thence

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* *This form of decussation denied by some authors.*

through orbits to enter eyeballs $\frac{4}{25}$ in. within and $\frac{1}{25}$ in. below post. pole. Length of nerve from chiasm to foramen $\frac{2}{5}$ in.; from latter to eyeball about $1\frac{1}{8}$ in.; nerve consists of bundles of medullated fibres, forming about half its bulk, separated from each other by connective tissue and vessels. Closely enveloped by neurilemma, a continuation of pia-mater—*pial sheath*—which sends processes between bundles of nerve-fibres and blends finally with inner layer sclerotic. After entering optic foramen, surrounded by outer, fibrous sheath — *dural sheath* — continuous with dura-mater and with periorbita (p. 4); has inner layer, usually closely adherent to it, corresponding to cerebral arachnoid; about $\frac{1}{4}$ in. from eyeball splits into two, then into four layers, which pass into post. and middle layers of sclerotic. Sheaths joined together by loose connective tissue and supplied by twigs from ciliary and muscular arteries. Space between them called *inter-vaginal*, *sub-vaginal*, or *sub-dural space*. At entrance into sclerotic nerve becomes thinner and fibres lose medullary sheaths; tendon-like processes from neurilemma more abundant, joined by fibres from sheath of central artery and from sclera, forming *lamina cribrosa*, which covers scleral opening like a sieve with convexity backwards; sometimes contains pigment. Beyond this, nerve-fibres slightly elevated above inner surface of sclera, forming *optic papilla* or *optic disc*,—a round-

ish prominence about $\frac{1}{17}$ in. diameter. (p. 57). Nerve-fibres radiate from disc into retina in all directions. *Central artery of retina*, or *arteria centralis retinæ* [Lat. equiv.], enters nerve $\frac{3}{5}$–$\frac{4}{5}$ in. behind eyeball and runs forward in centre of nerve to papilla where it branches into retina. Enclosed in sheath of its own. Nutrient capillaries of nerve from ant. cerebral, central artery, and vessels of neurilemma; anastomose in papilla with branches from short ciliary. *Central vein* accompanies artery, enclosed in separate sheath: leaves nerve a little nearer eyeball; empties into cavernous sinus, anastomosing with ophthalmic and so with facial. *Lymphatics* numerous in nerve and sheaths. Space between sheaths regarded as lymph-space, with which lymphatics of nerve and post. parts of eye connect.

EYEBALL, OR BULBUS OCULI.

In ant. part orbit to outer side of its axis, about equi-distant from upper and lower walls. Spheroidal form with segment of smaller sphere projecting from ant. surface. Antero-posterior diameter about .95 in. Transverse, .92 in. Vertical, .90 in. Weight, 6.3–8 grammes. Volume, about $\frac{1}{3}$ cubic in. *Anterior pole*, geometric centre of cornea. *Post. pole*, geometric centre of back part of globe, or *fundus* (Lat. for *bottom*). *Optic axis*,

imaginary straight line from pole to pole. *Visual line*, imaginary straight line through nodal point from macula lutea to object: cuts cornea within and above optic axis at angle with latter of 3–7°. *Nodal point*, centre of curvature of refracting surfaces. *Equatorial plane*, imaginary plane through centre, perpendicular to axis, dividing globe into *ant.* and *post. hemispheres*. *Equator*, line where eq. plane cuts surface. *Meridional planes*, imaginary planes coinciding with axis. *Meridians*, lines where meridian planes cut surface.

Eyeball composed of 3 tunics:

(a) *sclerotic* and *cornea*,

(b) *uveal tract*, or *tunica vasculosa*, comprising *choroid*, *ciliary body* and *iris*,

(c) *retina;*

and 3 humors:

(a) *aqueous*,

(b) *crystalline*,

(c) *vitreous*.

SCLEROTIC, OR SCLERA.

[Gr. σκληρος, hard.]

Opaque post. $\frac{5}{6}$ outer tunic, of which ant. $\frac{1}{6}$ is formed by cornea. Seen between lids anteriorly as "*white of the eye*." Forms firm capsule for globe, helping to maintain proper shape and protect parts within. Gives attachment to ocular muscles. Thickest posteriorly ($\frac{1}{25}$ in.) where it is joined by optic sheaths; at

ant. border, $\frac{1}{60}$ in. thick. Foramen posteriorly to inner side of centre, for optic nerve-entrance (p. 57); $\frac{1}{13}$ in. diameter. Terminates anteriorly in cornea, elements being transformed into corneal tissue; union by bevelled surfaces, sclera overlapping cornea anteriorly, and to slighter extent posteriorly; slight circular depression, or *sulcus*, around corneal margin. Outer surface somewhat rough, connected by loose connective tissue to sheath of globe, and anteriorly to conjunctiva by shorter filaments—*subconjunctival tissue*. Inner surface closely connected to choroid and ciliary body by layer of connective tissue, *lamina fusca*, containing pigment-cells. Sclera composed chiefly of connective tissue with elastic fibres, pigment-cells, and cells corresponding to corneal corpuscles, intermixed. Connective-tissue bundles have longitudinal and circular course interlacing to form dense mesh-work: form circular ring at ant. edge around cornea. Pigment-cells most abundant at inner surface. At ant. edge near inner surface is circular space surrounding cornea, *Schlemm's canal*, lined by endothelium and enclosing venous plexus: receives veins from sclera and from ciliary plexus; communicates with ant. chamber and ant. ciliary veins; regarded by some as venous reservoir for ciliary muscle. Sclera pierced around optic nerve entrance by long and short ciliary arteries, post. ciliary veins and short ciliary nerves; in

region of equator by venæ vorticosæ ; around corneal border by ant. ciliary arteries and veins; passages of long and ant. ciliary arteries and vorticose veins very oblique. Sclerotic receives blood from ciliary system ; vessels not numerous, and form coarse net-work : contains around optic nerve-entrance the *post. vascular zone* (zone of Zinn or Haller), formed from twigs of short ciliary, which sends branches to optic nerve anastomosing with those of central artery ; thus forming the only connection between ciliary and retinal systems. On ant. surface, around cornea, is *ant. vascular zone* formed from episcleral or subconjunctival branches of ant. ciliary vessels ; about $\frac{1}{6}$ in. wide ; anastomoses with conjunctival vessels. Existence of nerves in sclera doubtful.

CORNEA.

[Lat. *cornu*, a horn.]

Transparent, highly-polished membrane, forming anterior $\frac{1}{6}$ of external tunic and projecting from sclerotic like segment of smaller sphere. Ellipsoidal shape with radius of curvature a little less than 8 mm. Slightly more convex in vertical than in horizontal meridian. Transverse diameter longer than vertical, owing to overlapping of sclerotic above and below. Thickness at centre, $\frac{1}{28}$ in. ; at periphery, $\frac{1}{22}$ in. Refractive index, 1.342. Distinguish five layers from without inwards :—

(1.) *Conjunctival epithelium.*

(2.) *Ant. elastic lamina*, Bowman's or Reichert's membrane.

(3.) *Substantia propria*, or true corneal tissue.

(4.) *Post. elastic lamina*, or *Descemet's* membrane.

(5.) *Post. epithelium.*

Layer of conjunctival epithelium, $\frac{3}{2500}$ in. thick; consists of 2–3 layers transparent nucleated cells, superficial ones flattened, deeper ones oblong and placed perpendicularly to surface: passes over at edge (*limbus*) of cornea into epithelium of ocular conjunctiva. *Bowman's membrane* $\frac{1}{5000}$–$\frac{1}{2500}$ in. thick, firm, elastic, homogeneous basement-membrane, quite resistant to chemical agents. *True corneal tissue* about $\frac{1}{25}$ in. thick; consists of fine, highly-refractive, connective tissue fibrillæ united into bundles and these again into lamellæ, whose general direction is parallel to surface; space between fibrils, bundles and lamellæ is filled by semi-fluid, cement-like substance; in this is system of anastomosing spaces and canals containing serous fluid, network of corneal corpuscles, and wandering cells (?). Corneal corpuscles are flat or fusiform nucleated cells, with granular protoplasm, sending out anastomosing processes in all directions. Wandering-cells are lymphoid corpuscles endowed with amœboid movement. *Descemet's mem-*

brane $\frac{1}{2500}$ in. thick at margin ; $\frac{1}{3500}$ in. at centre ; elastic, structureless inner basement membrane, said by some to have lamellar formation ; continuous at margin with ligamentum pectinatum of iris. *Posterior epithelium*, forms endothelium of Descemet's membrane ; layer of flattened, polygonal, nucleated cells. *Blood-vessels :* none, except at periphery, where there is a zone $\frac{1}{25}$–$\frac{1}{18}$ in. wide, of capillary loops formed from episcleral branches of ant. ciliary arteries ; anastomose with conjunctival branches ; veinlets empty into ant. ciliary. *Nerves :* 20–45 twigs chiefly from ciliary, few from conjunctival ; former enter through sclera ; latter pass in from limbus. Just after entering cornea lose medulla ; form very intricate network beneath Bowman's membrane and in ant. epithelial layer, and smaller plexus near Descemet's membrane ; fibres run forward and end among superficial epithelial cells in manner not yet settled.

UVEAL TRACT (p. 8).

[Lat. *uva*, grapes.]

CHOROID [Gr. χοριον, *chorion*, and ειδος, *like*] :—runs from edge of optic nerve-entrance to imaginary boundary, *ora serrata*, a little in front of equator. Lies between sclerotic and retina, to which it is most closely attached around nerve and at *ora*. Thick-

ness, $\frac{1}{300}$–$\frac{1}{150}$ in. Following layers from sclerotic inward :—

(1.) *Lamina fusca* [Lat. *fuscus*, dark], or *supra-choroidea.*

(2.) *Tunica vasculosa.*

(3.) *Membrana chorio-capillaris*, or *Ruyschiana.*

(4.) *Lamina elastica*, *vitreous* or *limiting membrane.*

Inner pigment-layer, often described with choroid, belongs to retina. *Lamina fusca* composed of connective tissue containing free nuclei, and nucleated, branching pigment-cells, brown and black; surrounds vessels and nerves passing forward to iris and ciliary body; leaves space—*supra* or *peri-choroidal* space—between choroid and sclera, lined by endothelium, communicating with Tenon's space through canals around venæ vorticosæ; considered as lymph-space. *Tunica vasculosa* consists of the larger arteries and veins, which run tortuous course and pass gradually into deeper capillary layer. *Membrana chorio-capillaris*, fine capillary network covering inner surface from optic nerve to ora serrata; meshes finest posteriorly. *Limiting membrane*, about $\frac{1}{60000}$ in. thick; structureless, hyaline membrane covering inner surface of capillary layer. Elements of choroid are bound together by *stroma*—a network of fibres in whose meshes are variously-formed pigment-cells and lymph-

oid corpuscles. Smooth unstriped *muscular fibres* have been found along vessels, and scattered through stroma. Pigment less abundant in light eyes. *Arteries :* short posterior ciliary which become wholly lost in capillary layer not passing beyond ora serrata ; recurrent branches from long posterior and anterior ciliary. *Veins :* after very numerous ramifications and anastomoses unite into larger *venæ vorticosæ*, 4–6 in number, which pass out through sclera near equator ; carry off most of blood from uveal tract, only a small part escaping by ant. ciliary veins. *Nerves* from 3d, 5th and sympathetic, through long and short ciliary, which pierce sclerotic around optic nerve-entrance ; form fine network in which many ganglionic cells are found.

CILIARY BODY is portion of uveal tract between *ora serrata* and iris, being direct continuation of choroid ; consists of ciliary muscle, covered by choroidal stroma, and ciliary processes. *Ciliary muscle* or *tensor choroideæ ;* layer of unstriped muscular fibres, situated in anterior and outer part of ciliary body, separated from sclerotic by lamina fusca : in vertical section has prismatic shape, base forward, $\frac{3}{25}$–$\frac{4}{25}$ in. long, $\frac{1}{32}$ in. thick at base ; external fibres have meridional course forming thickest part of muscle ; middle fibres diverge and radiate toward inner side, where they form a circular plexus ; at ant. internal

angle are separate, circular bundles, the *annular muscle of Müller;* meridional and radiate fibres arise by tendinous ring from inner side of Schlemm's canal from which some pass forward into cornea; are connected with ciliary processes and choroid. Supplied by 3d nerve. Ciliary muscle is probably the exclusive agent in *accommodation*, but exact mode of its action is not settled: favorite theory is that of Helmholtz,—that meridional fibres draw choroidal border forward and circular fibres draw parts inward, thus relaxing zonula and allowing lens to become more convex from its own elasticity. During accommodation, the pupil contracts, the periphery of the iris moves backward, the lens is pushed forward, its anterior and posterior surfaces becoming more convex. The ciliary muscle was discovered by Brücke in 1846: first complete description by Müller in 1857.

CILIARY PROCESSES; 70–80 parallel, meridional folds of choroid, rising gradually from behind forward, and forming plaited zone—looking like a ruffle—on inner surface of ciliary muscle: about $\frac{1}{10}$ in. long; possess same structure as choroid, without its capillary layer; covered internally by continuation of retinal pigment: joined by external (anterior) margins to ciliary muscle, internal (posterior) margins and bases being free and resting in corresponding depressions on surface of zonula; space about $\frac{1}{50}$ in. wide left be-

tween bases of processes and border of lens.

Arteries of ciliary body:—Long post. ciliary run forward, one on outer and one on inner side of globe, penetrate ciliary muscle and, with branches from anterior ciliary, form *circulus arteriosus major* at its anterior border; smaller circle formed in same way farther back; capillary plexus of muscle derived from circles and also directly from ciliary arteries. *Arteries of ciliary processes* derived from *circulus major*. *Veins* of muscle and processes empty chiefly into venæ vorticosæ, some joining with ant. ciliary.

IRIS [Gr. *iris*, a rainbow]. Uveal tunic bends sharply in toward optic axis, $\frac{1}{25}$ in. from corneal margin, to form iris—a circular diaphragm with central opening called *pupil*. Pupil situated a little to nasal side of centre; mean diameter $\frac{2}{25}$–$\frac{6}{25}$ in.; fringed with pigment from bevelling off of anterior rim; varies in size from muscular action; when dilated to maximum, edge floats free in aqueous humor; when contracted, rests on anterior capsule of lens. Iris $\frac{7}{50}$–$\frac{9}{50}$ in. wide; $\frac{1}{125}$–$\frac{2}{125}$ in. thick. Attached at ciliary margin by its suspensory ligament, *ligamentum pectinatum iridis*, formed by radiating fibres which run from margin of anterior surface and bend forward at edge to join fibrous network around border of Descemet's membrane. Anterior surface un-

even, divided by jagged line into two zones: (1) *pupillary*, $\frac{1}{25}$ in. wide, and marked by fine radiating folds; (2) *ciliary*, $\frac{3}{25}$ in. wide (allowing $\frac{4}{25}$ in. for pupil), and marked by 5 to 7 concentric folds; covered by layer of irregular cells continuous with those of Descemet's membrane. Post. surface covered by layer of pigment-cells, *tapetum* or *uvea* [Lat. *tapete*, *carpet*], continuous with pigment layer of ciliary processes; marked by 70–80 shallow, radiating folds. *Stroma* is loose, connective-tissue network, continuous with that of choroid and ciliary body, containing muscular fibres, vessels, nerves, round and stellate cells. In dark eyes, cells are strongly pigmented and often seen as superficial, irregular spots. In light eyes, cells are non-pigmented and color is an *interference phenomenon*. Layer of circular muscular fibres about $\frac{3}{500}$ in. thick and $\frac{1}{25}$ in. wide around border of pupil forming *sphincter pupillæ*. Radiating fibres, *dilatator pupillæ*, run from ciliary border toward pupil; form network within sphincter and unite with it. Muscular fibres lie near post. surface, being separated from uvea by thin limiting membrane. *Arteries* from *circulus major iridis* in ciliary muscle; walls very thick; run toward pupil, giving out branching network, and near pupillary margin form *circulus arteriosus iridis minor;* end in loops and pass into veins at edge of pupil. In albinos, color of blood

shows through walls of vessels. *Veins* mostly pass back to plexus of ciliary processes and so into venæ vorticosæ; some through veins of ciliary muscle into ant. ciliary. *Nerves* from 3d, 5th, and sympathetic through long and short ciliary; form fine plexus in stroma; sphincter supplied by 3d, dilatator by sympathetic; sensitive fibres from 5th. Movements of iris *reflex* from action of light on retina, and *accommodative* in unison with ciliary muscle; movements of the two irides consentaneous.

Retina.

[Lat. *rete*, a net.]

Inner tunic of eye lying between choroid and vitreous body from optic nerve to ora serrata. Delicate grayish color, quite transparent: about $\frac{1}{75}$ in. thick at papilla, growing thinner toward ora serrata, where it is about $\frac{1}{200}$ in. thick. Composed of nervous elements and modified connective tissue like neuroglia of brain. Layers from vitreous outward:—

(1) *Membrana limitans interna.*
(2) *Optic nerve fibres.*
(3) *Ganglion cells.*
(4) *Internal molecular.*
(5) *Internal granules.*
(6) *External molecular or intergranular.*
(7) *External granules.*
(8) *Limitans externa.*

(9) *Rods and cones* or *Jacob's membrane.*

(10) *Pigment layer.*

(1) Hyaline memb. made up from retinal connective tissue : $\frac{1}{12500}$ in. thick.

(2) Transparent, homogeneous fibres, like those of brain, radiating from optic papilla in all directions, devoid of medullary sheaths; not sensitive to light : layer $\frac{1}{125}$ in. thick posteriorly, decreasing toward ora.

(3) Ganglion-cells with nuclei and nucleoli, having branching processes in variable number, some of which appear identical with nerve-fibres : layer about $\frac{3}{5000}$ in. thick.

(4) Finest nerve-fibres and connective-tissue network; fine granules of unknown nature : layer about $\frac{1}{1200}$ in. thick.

(5) Small round cells with large nuclei connected with radial connective-tissue fibres and nerve-fibres ; processes from cells pass through molecular layer and unite with ganglion-cells (?) ; layer about $\frac{1}{1300}$ in. thick.

(6) Connective tissue, nuclei, granular substance, nerve-fibrillæ : layer about $\frac{1}{2000}$ in. thick.

(7) Ellipsoidal-shape, transversely striated, with long axis perpendicular to plane of retina; form nucleated enlargements of internal rod and cone fibres which run through this layer to reach (6) in which they arise (?). Inner part of layer devoid of granules—*ext. fibre layer* of Henle. Layer $\frac{1}{1000}$–$\frac{1}{500}$ in. thick.

(8) Membranous expansion of radial con-

nective-tissue fibres ; not continuous, but perforated by numerous foramina.

(9) Is *perceptive* layer. Rods and cones packed together like palisades forming external nervous layer; probably termini of optic-nerve fibres ; have striated appearance from fine lines of connective tissue surrounding them ; divided into external and internal segments connected together by sheath and filled with highly refractive molecular matter; delicate fibres, *rod and cone fibres*, run inward from rods and cones and appear to arise by club-shaped and finely-fibrillated expansions in ext. molecular layer: ext. granules are connected with them. Existence of axial fibres in rod and cones doubtful. Rods are cylindrical, $\frac{1}{500}$ in. long, $\frac{1}{8300}$ in. thick. Cones flask-shaped, about $\frac{1}{800}$ in. long, $\frac{1}{5000}$ thick. Layer about $\frac{1}{500}$ in. thick.

(10) Hexagonal cells pressed closely together containing brownish-black pigment and held together by homogeneous connective tissue ; send processes inward which surround rods and cones—*pigment-sheaths:* closely connected externally to choroid. Pigment almost absent in albinos, small amount in blondes, most in negroes.

Supporting connective tissue consists of radial fibres stretched between limitans externa and interna, and spongy tissue, forming networks and sheaths for nervous elements.

Yellow spot, or *macula lutea* [Lat. *equiv.*]

of Sœmmering :—most sensitive part of retina and centre of direct vision. Situated about $\frac{1}{12}$–$\frac{1}{10}$ in. to outer side of centre of optic disc. Horizontally oval and of variable size, $\frac{1}{25}$–$\frac{1}{17}$ in. diameter. Has central fossa-like excavation, *fovea centralis*, $\frac{1}{125}$–$\frac{2}{125}$ in. in diameter. Nerve-elements of retina crowded together in macula at expense of connective tissue: ganglion cells and ext. granule layer thicker; rods replaced by closely-packed cones which converge toward centre; rod and cone fibres run diagonally or parallel to retinal surface; nerve-fibre layer interrupted, fibres passing around macula in curves : pigment cells increased, longer than broad, and darker color.

Ora serrata [Lat. for *serrated boundary*] :—anterior limit of retina situated just posterior to ciliary body; gradual disappearance of nervous elements here, leaving only connective tissue and pigment layers which are continued forwards over ciliary body as *pars ciliaris retinæ*.

Blood-vessels of retina : from central vessels of optic nerve which divide in papilla or just behind it; run chiefly up and down, generally two arteries and two veins in each direction: divide in arborescent manner and terminate in capillary network : do not pass beyond ora serrata : main branches lie in nerve-fibre layer, capillaries passing as far as internal granules ; only capillaries at macula and no vessels whatever in fovea.

Vessels said to be surrounded with lymphatics connecting with those of optic nerve.

CRYSTALLINE LENS.

Biconvex, transparent, elastic body, resting in hyaloid fossa of vitreous immediately behind pupil, enclosed in capsule and held in place by suspensory ligament. Anterior surface about $\frac{1}{7}$ in. from ant. surface of cornea; axis a little to outer side of centre of cornea. More convex on post. surface than anterior; radius curvature of former about $\frac{6}{25}$ in.; of latter, about $\frac{2}{5}$ in. Curvature greater in horizontal than in vertical meridian. About $\frac{9}{25}$ in. diameter; $\frac{33}{250}$–$\frac{39}{250}$ in. axis; weight, 4–4½ grs. refractive index, 1.44–1.45. Contains 60 per cent. water, 35 per cent. soluble and 2½ per cent. insoluble albuminous matter, 2 per cent. fat, with cholesterine. *Capsule* is transparent, elastic, homogeneous membrane surrounding lens and divided into ant. and post. portions: thickest anteriorly ($\frac{1}{2000}$ in.), thinner at margin ($\frac{1}{6000}$ in.), and thinnest at post. pole. On post. surface of ant. capsule is layer of flat, polygonal cells with round nuclei (formerly considered epithelial) which gradually elongate towards border of lens into true nucleated lens-fibres. Body of lens is composed of flattened hexagonal fibres with dentated lateral edges by which they are joined together more firmly than by their flattened surfaces, thus

giving idea of *layers* when they are torn apart. Each fibre curves around edge of lens, lying in both halves of same layer ; greater part do not reach pole but join corresponding ones at acute angle, forming *seams* which run out from pole like rays of star and extend through whole substance of lens so as to divide it into sections. Centre of lens is unstratified, denser, and is called *nucleus*, surrounding part being *cortex*. Existence of cement-like substance between fibres doubtful. *Liquor Morgagni* results from deliquescence of cortical layers and is wholly due to *post-mortem* change. Lens fibres called *tubes* by some authors. Lens has no vessels or nerves; receives nutriment by imbibition from uveal tract, vitreous and aqueous. In fœtus is covered by vascular sac from hyaloid artery, which also closes pupil—*membrana capsulo-pupillaris*. Lens grows by deposition of new fibres : cell-layer on post. surface of ant. capsule considered as matrix.

Suspensory ligament, *zonula ciliaris*, or *Zonula Zinnii* : begins just behind ora serrata by fine filaments which run longitudinally forward intimately blended with retina, tapetum and hyaloid memb. of ciliary processes, some passing into vitreous. In ciliary region these fibres divide into two layers, anterior going to ant. and posterior to post. capsule of lens. Between these two folds and border of lens is triangular space—*canal of Petit*—closed dur-

ing life by folds falling together. Canal begins $\frac{1}{5}$ in. from ora serrata, runs to border of lens and extends $\frac{1}{12}$ in. along post. capsule toward pole (?).

VITREOUS HUMOR, HYALOID BODY, OR CORPUS VITREUM.

[Gr. ὑαλος, glass, and ειδος, like. Lat. *vitreum*, glass.]

Fills interior of eyeball behind lens. Structureless, gelatinous substance containing nuclei and cells (chiefly in peripheral parts) and connective-tissue filaments. Cells round, oval, stellate (?), nucleated and finely granular; endowed with mobility (?). Vitreous appears to have a cortex, composed of concentric layers, and a nucleus which lies anteriorly to centre (?). *Canal of Cloquet*, or *hyaloid canal* ($\frac{1}{25}$ in. diameter) runs through centre from papilla to lens; contains hyaloid artery in fœtal life, of which rudiment sometimes persists. No limiting or hyaloid membrane; bounded posteriorly by limiting membrane of retina, anteriorly by zonula and post. capsule of lens. Ant. surface hollowed out, forming *fossa hyaloidea* or *patellaris* in which lens rests. Receives nutriment from retina and uveal tract. Contains no vessels or nerves.

AQUEOUS HUMOR.

Clear, slightly viscid, serous fluid filling

anterior and posterior chambers; weight $3\frac{1}{2}$–5 grs.; sp. grav. 1.0053; composed of water (96.687 parts), albumen (.1223 parts), salts and extractive matter. Refractive index, 1.3366.

Anterior chamber is space between ant. surface iris and lens and post. surface cornea. *Posterior chamber* is space between ant. surface lens, zonula and ciliary body behind, and post. surface iris in front. When pupil is dilated and edge does not rest on lens, the two chambers communicate.

MUSCLES OF THE EYEBALL.

Eye is moved by 6 muscles, 4 *recti* and 2 *oblique*. Centre of motion lies on optic axis 1.77 mm. (about $\frac{1}{14}$ in.) behind its centre. Rotary power greater inward and downward than upward and outward. Muscles of both eyes act in harmony, and movements are either *associated* (visual lines being parallel) or *accommodative* (visual lines convergent and ciliary muscle and sphincter of pupil participating). When all the muscles are at rest the visual lines converge toward a point 8″–12″ in front of eyes, angle between them being called the *muscular mesoropter*. *Muscle plane* is plane passed through centre of motion and line passing from middle of origin to middle of insertion of muscle. *Axis of*

turning is perpendicular to muscle-plane at turning point. *Base line*, line connecting centres of motion. *Median plane*, plane passed through vertical axis of head and centre of base line. *Visual plane*, plane passed through base line and visual lines. *Vertical meridian* is drawn perpendicular to equator when eye is in primary position. *Primary position* is that in which visual lines are horizontal and parallel to median plane, head being erect ; all other positions are called *secondary*.

The 4 *recti* arise from tendinous ring around optic foramen, run forward divergently, strike the sheath of the eyeball just behind equator and pierce it just before their insertion into the anterior part of sclerotic ; tendons are flat and lines of their insertions are convex anteriorly. Muscles are surrounded by sheaths from orbital connective tissue, which unite with Tenon's capsule ; this connection keeps muscles against globe and prevents too great retraction of tendons after division.

Superior rectus : O. upper edge optic foramen. I. sclerotic about $\frac{1}{3}$ in. from edge of cornea, inner end nearer cornea, than outer. Moves eye upward and inward, and inclines vertical meridian inward.

Inferior rectus : O. lower edge optic foramen. I. sclerotic about $\frac{2}{7}$ in. from cornea, a little to nasal side of centre. Moves eye

downward and inward; vert. meridian outward.

External rectus: O. external edge optic foramen. I. sclerotic about $\frac{1}{3}$ in. from cornea. Moves eye outward, not inclining vert. meridian.

Internal rectus: O. internal edge optic foramen. I. sclerotic about $\frac{1}{4}$ in. from cornea. Moves eye inward, not inclining vert. meridian. Is strongest muscle.

Superior oblique: O. $\frac{1}{25}$–$\frac{2}{25}$ in. anterior to inner edge optic foramen: passes forward to upper and inner angle of orbit, over pulley, thence outward and backward, beneath sup. rectus, to upper, outer, and posterior quadrant of eyeball, where it pierces ocular capsule and has fan-shaped insertion into sclerotic, about $\frac{3}{5}$ in. from cornea. Moves eye downward and outward, inclining vert. meridian inward. *Pulley* (*trochlea*) of sup. oblique, is tendino-cartilaginous ring attached to depression at anterior, inner angle orbital plate of frontal bone.

Inferior oblique: O. anterior, inner angle orbital part of sup. maxillary bone, just external to lachrymal sac: passes outward, downward and backward beneath inf. rectus, then upward and backward between ext. rectus and globe, and piercing ocular sheath inserts into sclerotic close to sup. oblique, about $\frac{2}{3}$ in. from cornea. Moves eye

upward and outward, inclining vertical meridian outward.

Movement.	Muscle.
Upward	Sup. rectus and inf. oblique.
Downward	Inf. rectus and sup. oblique.
Inward	Int. rectus.
Outward	Ext. rectus.
Upward and inward	Sup. and int. recti and inf. oblique.
Upward and outward	Sup. and ext. recti and inf. oblique.
Downward and inward	Inf. and int. recti and sup. oblique.
Downward and outward	Inf. and ext. recti and sup. oblique.

(*Wells.*)

The 3d (*oculo-motorius*) nerve supplies the superior, inferior and internal recti and inferior oblique.

The 4th (*trochlear*) nerve supplies superior oblique.

The 6th (*abducens*) nerve supplies external rectus.

The arteries of the muscles come from the ophthalmic.

The veins empty into ophthalmic and facial.

BLOOD-VESSELS OF THE EYE.

Arteries: chiefly from *ophthalmic*, which arises from internal carotid at anterior clinoid process; about $\frac{1}{12}$ in. calibre; enters orbit below and external to optic nerve, then crosses above nerve, between it and sup. rectus muscle, to inner wall and runs forward to inner angle: gives off *lachrymal*, *supra-orbital*, *anterior* and *posterior ethmoidal*,

anterior ciliary, *long* and *short posterior ciliary*, *muscular*, *palpebral*, *centralis retinæ*, *frontal* and *nasal* (terminal branches). *Infra-orbital* (from int. maxillary of ext. carotid) sends branches to inf. rectus and inf. oblique muscles, and to lachrymal gland. *Anterior cerebral* sends nutrient capillaries to optic nerve. In eyeball itself are two systems: (1) *the retinal*, derived from the *centralis retinæ* vessels, which supplies retina and optic nerve; and (2) *the choroidal* or *ciliary*, from ciliary vessels, which supplies uveal tract, sclerotic, margin of cornea and part of ocular conjunctiva. The *short ciliary*, arising from ophthalmic or one of its branches, are 4 to 6 small twigs which divide into about 20 and perforate sclerotic around optic nerve. The *long ciliary* having same origin as short, are two branches which perforate sclerotic a little further forward, one on medial and one on lateral side. The *anterior ciliary*, arising from muscular branches, pass through tendons of muscles and perforate sclerotic near corneal margin. The only connection between the two above systems is by small twigs around optic nerve entrance (p. 7).

Anastomosis: with deep temporal and transverse facial by malar branches, and middle meningeal by posterior branch from lachrymal. With anterior temporal and angular by supra-orbital. With infra-orbital

and angular by nasal. With spheno-palatine by ethmoidal.

Veins : Smaller branches empty into 2 main trunks, *superior* and *inferior ophthalmic*, which run along roof and floor of orbit to cavernous sinus ; have free anastomosis with facial in front ; blood can thus escape from orbit in either direction. The short post. ciliary veins are very small and receive blood only from sclerotic. There are no veins corresponding to long ciliary arteries.

LYMPHATICS.

Lymph formed in eyeball anterior to ciliary body passes out through anterior chamber and canal of Schlemm. That formed in posterior parts escapes through channels near venæ vorticosæ and through optic nerve. Spaces between choroid and sclerotic (*supra-choroidal* or *peri-choroidal*), between globe and capsule (space of Tenon), and between sheaths of optic nerve (*supra-vaginal* and *sub-vaginal*) are regarded as lymph-spaces.

NERVES OF THE EYE.

(a) *Special sense;* 2d or optic. (b) *Motor;* 3d, 4th, 6th, filaments of 5th and sympathetic. (c) *Sensory ;* ophthalmic division of 5th. (d) *Sympathetic branches.*

Optic nerve : (p. 5).

Third (*motor oculi*): supplies sup., inf., int. recti, inf. oblique, and levator palpebræ. Joined by motor nerves of accommodation and sphincter nerves of iris, which are supposed to have separate origin in brain. Sends branch to ciliary ganglion. Receives sympathetic filaments from cavernous plexus.

Fourth (*trochlear*, *patheticus*): supplies sup. oblique. Receives sympathetic filaments from carotid plexus. Sometimes blends with ophthalmic. Sometimes sends branch to lachrymal.

Sixth (*abducens*): supplies ext. rectus. Receives filaments from carotid plexus, from Meckel's ganglion and from ophthalmic.

Ophthalmic division of 5th: joined by sympathetic filaments from cavernous plexus. Gives off: (1) *Lachrymal*, which supplies lachrymal gland, conjunctiva, skin upper lid, anastomosing with branches from sup. maxillary and facial. (2) *Frontal*: *a*. supra-trochlear to corrugator supercilii, joining with infra-trochlear; *b*. supra-orbital to upper lid, corrugator and orbicularis, joining with facial. (3) *Nasal* or *naso-ciliaris*: *a*. ganglionic to ciliary ganglion. *b*. long ciliary, 2–3, joining short ciliary and going to ciliary muscle and iris; *c*. infra-trochlear to orbicularis, lids, conjunctiva, lachrymal sac and caruncle, joining branch from supra-trochlear.

Sympathetic branches: arise from medulla, cilio-spinal region, cavernous and carotid

plexuses. Join 3d, 4th, 5th, and 6th nerves. Send filaments to dilatator muscle iris, to organic muscles orbit and lids, to ciliary ganglion and to walls of vessels.

Ophthalmic, lenticular, or *ciliary ganglion;* lies in back part of orbit between optic nerve and ext. rectus ; reddish color ; $\frac{1}{12}$ in. diameter; receives root from cavernous plexus sympathetic, long root from nasal of ophthalmic, short root from 3d. Gives off short ciliary branches 2–3 in number, which subdivide into about 20, pierce sclerotic about $\frac{1}{6}$ in. from optic nerve and go to ciliary muscle, iris, choroid, and cornea ; send fine branches to sheath of optic nerve.

Ascending branches spheno-palatine or *Meckel's ganglion*, enter orbit by sphenomaxillary fissure, and go to optic and 6th nerves and ophthalmic ganglion.

APPENDAGES OF THE EYE.

EYEBROWS or SUPERCILIA [Lat. equiv.] : Arched elevations of skin above orbit covered with row of short hairs ; serve to protect eye and to influence slightly amount of light admitted. *Corrugator supercilii muscle* arises at inner end superciliary ridge and is inserted into under surface of *orbicularis*, blending with *occipito-frontalis :* supplied by facial and supra-orbital nerves ; draws brow downward and inward.

EYELIDS or PALPEBRÆ [Lat. equiv.]: Two movable, protecting folds placed before eyes closing entrance to orbit. Upper lid about $\frac{4}{5}$ in. lower about $\frac{1}{2}$ in. high—measured on inner surface. Space between free margins called *palpebral fissure*. Outer angle of fissure called *external canthus;* inner angle *internal canthus* [Gr. κανθος, *angle of eye*]. Small space between lids and globe at inner angle called *lacus lachrymalis* [Lat. for *lachrymal lake*]. On edge of each lid about $\frac{1}{5}$ in. from inner canthus is small elevation—*lachrymal papilla* containing minute orifice—*punctum* [Lat. for *small hole*]—the beginning of a lachrymal canal or *canaliculus*. Lids composed of skin externally, mucous membrane internally, and between these areolar tissue, muscle, cartilage, ligaments, glands, vessels and nerves. Skin is continuation of general integument and continuous at edge of lid with conjunctiva. Is thin, lax, and contains a few fine hairs. Subcutaneous areolar tissue very loose and contains sweat glands and hair follicles. The *tarsal cartilages* form framework of lids; that of lower lid being elliptical, that of upper crescentic and larger. Orbital margins are thinned and pass into fasciæ (*palpebral* or *tarsal ligaments*) which connect cartilages to edge of orbit. Free or ciliary margins thick and straight. Ligament thickened to connect outer angles of cartilages to malar bone and called *external palpebral* or *canthal ligament.*

Connection at inner canthus made by *tendo oculi* or *palpebrarum*, about $\frac{1}{6}$ in. long, lying just beneath skin ; attached to nasal process sup. maxillary bone in front of lachrymal groove ; passes horizontally across upper part lachrymal sac, sending aponeurosis back to crest of lachrymal bone ; then divides into two branches, one going to inner angle of each cartilage. *Meibomian glands* [*Meibomius, 17th cent.*], variety of cutaneous sebaceous glands imbedded in cartilages—30–40 in upper lid, 20–30 in lower ; each consists of blind tube into which open secondary follicles, *acini;* tubes lie parallel and open in row on inner lip free border of lid ; furnish sebaceous secretion. *Conjunctiva* [Lat. *conjungere*, to *join together*] ; mucous membrane lining lids, reflected thence upon front of sclerotic, passing slightly over edge of cornea—*limbus conjunctivæ* [Lat. *limbus*, a margin]. Continuous with integument, with mucous lining of Meibomian glands, canaliculi, lachrymal sac and nasal duct, and extends through lachrymal ducts into lachrymal gland. Where it is reflected upon eyeball—*fornix* [Lat. for *arch*], it forms *superior* and *inferior palpebral* or *retro-tarsal folds ;* also forms crescentic fold at inner canthus—*semi-lunar fold*, or *plica semilunaris* [Lat. equiv.]—regarded as rudiment of 3d eyelid or *membrana nictitans* in birds. Palpebral conjunctiva has pale, salmon color, with well-defined vessels here

and there; consists of connective-tissue basis covered by round, cylindrical and flat epithelium; surface traversed in all directions by furrows, and presents papillæ and papilliform elevations, and orifices of follicular glands; retro-tarsal folds present also conglomerate glands called *accessory lachrymal glands*, and papillæ are here more prominent. Ocular conjunctiva thin and loosely attached to globe; contains few papillæ and no glands; covered by epithelium which extends over cornea. *Blood-vessels* of conjunctiva chiefly from palpebral and lachrymal arteries; form thick net-work, indirectly connected through episcleral around corneal margin with ciliary system. *Lymphatics* numerous; form close network around edge of cornea. *Nerves*, from 5th pair, enter at inner and outer angles of eye; form thick plexus from which non-medullated fibres ramify beneath epithelium and end free—some apparently by club-shaped expansion.

Eyelashes, or *Cilia* [Lat. equiv.]: rows of short, thick hairs on free margins of lids, those of upper lid curving upward, those of lower downward; follicles lie in connective tissue beneath cartilage; sebaceous glands connected with follicles lubricate cilia.

Muscles: orbicularis palpebrarum arises from int. angular process frontal, nasal process sup. maxillary in front of lachrymal groove, and ant. surface and borders tendo oculi;

fibres surround lids and orbits, spreading over temple and cheek. Palpebral portion, arising from tendo oculi, covers lids between subcutaneous areolar tissue and cartilage; fibres unite by cellular raphé at outer angle, some passing into ext. canthal ligament and malar bone. Is sphincter of lids, palpebral portion having involuntary action. Supplied by facial, supra-orbital and sup. maxillary nerves. *Tensor tarsi*, or *Horner's muscle*, is part of orbicularis lying behind tendo oculi. Arises from upper 3d lachrymal crest, passes across sac and divides into two slips, one of which inserts into each cartilage near punctum, some fibres surrounding canaliculi and some running along edge of lid to outer angle. Draws lid inward and presses puncta against globe; supplied by facial nerve. *Levator palpebræ superioris* arises from upper edge optic foramen, runs along roof of orbit, and is inserted into fascia of upper lid around upper edge of cartilage. Raises lid; supplied by 3d nerve. Organic muscular fibres, *superior* and *inferior palpebral muscles*, exist in both lids between conjunctiva and cartilage. Supposed to assist in exact closure of lids upon globe; supplied by sympathetic nerves.

Arteries of lids: principal branches from ophthalmic, run along ant. surfaces of cartilages near free edges of lids, forming *superior* and *inferior tarsal arches;* from these arches run vessels to skin, muscles, cartilages and

conjunctiva ; free anastomosis with angular, ant. temporal, lachrymal, and transverse facial. *Veins* empty into temporal and facial.

Lymphatics empty into facial and submaxillary glands.

Nerves ; trifacial to skin and conjunctiva ; facial, 3d, and sympathetic, to muscles.

CARUNCULA LACHRYMALIS [Lat. *caruncula, a little piece of flesh*] : small red body lying on semilunar fold in inner canthus : consists of 13-15 hair-follicles and sebaceous glands, with connective tissue and fat : covered by mucous membrane and has few fine hairs on surface : attached to Tenon's capsule and rectus internus muscle by tendinous fibres, which fact explains sinking of caruncle after division of muscle.

LACHRYMAL APPARATUS.

Consists of secreting portion, *lachrymal gland*, and *accessory conjunctival glands ;* and conducting portion, *canaliculi*, *sac*, and *nasal duct*.

Lachrymal gland: composed of (1) *upper portion*—shape of almond, lying in fossa at outer angle roof of orbit, attached to bone by tarso-orbital fascia, under surface resting upon eyeball ; longest diameter, transverse, about $\frac{3}{8}$ in. ; weight, 11 gr ; (2) *lower portion*—group small glands arranged in row just above fornix conjunctivæ. Ducts 6-12 in number, very

minute, open in row at outer third upper reflection of conjunctiva. Vessels and nerves enter gland at post. border. Secretion of gland (*tears*) consists of water, salt and albumen; is spread over ant. surface globe, which it lubricates, by winking of lids; excess collects in *lacus*, and is forced into canaliculi by orbicularis and Horner's muscles, or flows over cheek. [Under ordinary circumstances tears evaporate, scarcely any passing into nose; and they come mostly from conjunctiva, so that extirpation of lachrymal gland does not materially affect moisture of globe.]

Canaliculi [Lat. for *little channels*]: two mucous canals $\frac{1}{4}$–$\frac{1}{3}$ in. long and about $\frac{1}{25}$ in. diameter, lined by pavement epithelium and enveloped by fibres of Horner's muscle: begin at puncta, run nearly horizontally, and open by common or separate orifices into outer wall lachrymal sac behind palpebral ligament. *Lachrymal sac:* lies in upper end lachrymal canal between border of lachrymal bone and nasal process sup. maxillary: oval form, flattened antero-posteriorly, about $\frac{2}{5}$ in. long and $\frac{1}{6}$ in. wide. Larger part lies below level of lower inner angle of orbit. Upper part (*fundus*) is crossed by tarsal ligament, extending about $\frac{1}{8}$ in. above it. Transition from sac to duct sometimes direct, sometimes interrupted by folds of mucous membrane. *Nasal duct:* runs in bony lachrymal canal, downward, backward, and out-

ward, curve varying in different subjects; $\frac{3}{5}$–$\frac{4}{5}$ in. long, about $\frac{1}{8}$ in. diameter; generally opens in inferior meatus nose, just below attachment inf. turbinated bone, sometimes lower: shape of opening varies with situation. Lined by thick mucous membrane covered with pavement and ciliated epithelium. Enclosed by very vascular network connective-tissue and elastic fibres, and, external to this, tendinous sheath, strengthened above by off-shoots from post. surface palpebral ligament and sheath of Horner's muscle.

Arteries and nerves of lachrymal apparatus are small twigs from neighboring trunks. Gland receives *lachrymal artery* from ophthalmic, and *lachrymal nerve* from 5th. Nerve governs secretion. [Hence flow of tears from mental states and from injury.]

SENILE CHANGES.

Are observed in most of the tissues of the eye. The *sclerotic* presents calcareous deposits, and a loss of elasticity favoring glaucoma. *Cornea* becomes smaller and thinner and loses tone; elastic laminæ become brittle and present warty elevations at margins. After 50 (rarely before), *arcus senilis* [Lat. for *senile bow*], or *gerontoxon* [Gr. γερων, *old man*, and τοξον, *bow*], appears, as result of fatty degeneration: begins on upper and lower margins in form of two superficial,

grayish, crescentic opacities with inner borders indistinct and outer well-defined, leaving rim of clear cornea on outer side. Opacities gradually extend deeper into tissue and ends join, forming ring. *Choroid* undergoes atrophy, becomes rigid and brittle, and presents fatty degeneration and calcareous deposits ; vessels become atheromatous and capillary layer may be partially destroyed : membrana limitans thickened. Analogous changes occur in ciliary muscle and processes. In *retina*, sclerosis of nerve-elements and connective tissue occurs, giving white dotted appearance : pigment is bleached and atrophied, causing uneven color : vessels become atheromatous. *Lens* increases in density, loses elasticity and becomes flatter : nucleus assumes amber color, and molecular opacities appear around it ; changes in lens-fibres cause radiating opacities : hyaline substance is deposited on post. surface of ant. capsule. *Zonula* becomes weakened, favoring dislocation of lens.

CHAPTER II.

EXAMINATION OF THE EYE.

As a general rule examine every part thoroughly, no matter what the symptoms.

Outer surface lids easily seen; magnifying glass may be used to examine their edges as to position, cleanliness, state of follicles, and curvature of lashes. Observe whether puncta are in proper position, and whether firm pressure with finger over the lachrymal sac causes any catarrhal secretion to ooze out of them. Inner surface lower lid seen by sliding its integument downward with tip of one finger while patient rolls eye upward. To *evert upper lid* have patient direct his eyes —not his head—downward; press skin of lid well against and under roof of orbit with thumb of right hand; then turn lid over with left hand, grasping its central lashes lightly between thumb and finger; thumb of right hand then removed, and applications, etc., made while left hand holds lid in everted position. Lid may be turned over a probe or pencil, if preferred. These manipulations often hindered in children from fear, obstinacy, photophobia, or spasm of orbicularis. Child's head should then be firmly held between surgeon's knees, while body is laid across lap of attendant, who must also hold its hands and arms. Lids can then be separated by fingers, or, if not, the upper one can be raised by *elevator*. If this is impracticable, or if eye is drawn out of sight by spasm of *sup. rectus*, ether should be given. Elevator sometimes required in other cases where too much swelling or soreness of upper lid to allow of its eversion.

When front of eye-ball is *red*, it is important to know whether congestion is superficial or deep. In former case, there may be a network of vessels with white interstices, or a uniform redness; the vessels are freely movable upon sclerotic, and can be emptied by pressing edge of lower lid against them while moving it over globe. In deep congestion (*ciliary congestion*) there is a rosy zone of fine, straight vessels radiating from edge of cornea, immovable, and unaffected by pressure. Both forms of congestion often mingled. When venous blood does not readily escape from interior of eye, large, dark, tortuous veins appear running over sclerotic, which they pierce near corneal margin. *Oblique illumination;* very useful for examining cornea, anterior chamber, iris, pupil, lens, and most anterior part of vitreous, showing minute details which escape naked eye. To produce it, focus daylight or lamplight upon cornea with 2½ inch convex-lens, observer's eye being in path of reflected rays. If lamp is used it should be to one side and somewhat in front of eye, on level with it and about 2 feet off. By moving lens the cone of light may be made to traverse all parts of front of eye. Appearances may be magnified by holding another strong convex lens directly in front of examined eye and observing through it. *Shape and movements of pupil* should be carefully noted. Latter best observed by excluding fellow-eye

with handkerchief, and then alternately shading and uncovering eye examined with hand. Pupil should contract promptly when exposed to light, and dilate more slowly when covered, always retaining its circular shape. The *intra-ocular tension*—very important as index of *intra-ocular circulation*—is estimated by degree of hardness of globe, although this is influenced also by elasticity of sclerotic, and varies greatly within health. The normal resistance gives a sensation which cannot be well described. Tension in disease varies between extreme softness and stony hardness. To test tension, direct patient to look down with closed lids, and placing both fore-fingers upon upper part of globe, make pressure and counter-pressure, much as when testing for *sense of fluctuation*. Always compare the two eyes. Bowman's signs are Tn. for normal tension, T+1, T+2, and T+3 for successive degrees increased tension; T−1, T−2, T−3 for degrees decreased tension; and sign of interrogation, used in case of doubt.

The acuteness of vision (V or S*). Supposed that normal eye sees distinctly under visual angle of five minutes—visual angle being that enclosed between two lines drawn from extremities of object to optical centre of eye. Acuteness of vision is estimated by

* German, *Sehschärfe*.

Snellen's test-types, which are so constructed that each number should be seen at corresponding distance under an angle of 5 minutes. No. 100 at 100 ft., No. 20 at 20 ft., etc. The formula is $V = \frac{d}{D}$, in which d equals distance at which letters are seen, and D, distance at which they ought to be seen. Thus, if type No. 50 is seen only at 20 ft. $V = \frac{20}{50} = \frac{2}{5}$. For the illiterate, figures, constructed on same principle, are used. When V is so reduced that type cannot be read, it is tested by ability to *count fingers* held between eye and light. If this cannot be done, there may still be *perception of light—qualitative* when there is some perception of form and outline, or *quantitative* when only difference between light and dark is appreciated. Where there is refractive-defect it should be neutralized by glasses before testing V.

The range (or *power*) *of accommodation*, $\frac{1}{A}$, expresses eye's power to adjust itself for divergent rays, and is found by formula $\frac{1}{A} = \frac{1}{P} - \frac{1}{R}$ in which P equals distance of nearest point, (p), of distinct vision, and R distance of farthest point (r). It is really represented

by that convex lens which, if placed at nodal point of eye, would give to rays coming from p a direction as if they came from r. For determining p and r it is customary to use Snellen's or Jaeger's test-types, selecting the smallest that can be distinctly seen. Although all rays which strike the eye are really divergent, those coming from an object 20 feet or more distant are regarded as practically parallel, and such a distance is called *infinite*. An eye which sees *distinctly* at 20 feet is said to have its far-point in infinity. An emmetropic eye when at rest is adjusted for parallel rays; its far-point lies in infinity, $\frac{1}{R} = \frac{1}{\infty}$. If it can still see distinctly to within a distance of 6 inches, $\frac{1}{A} = \frac{1}{6} - \frac{1}{\infty} = \frac{1}{6}$. The accommodative power of such an eye is always expressed by $\frac{1}{P}$. A hypermetropic eye may also see distinctly at an infinite distance, but only by exercising a part of its accommodation: its total accommodative power is expressed by $\frac{1}{P}$ *plus* the amount of hypermetropia. Thus, if $H = \frac{1}{24}$ and the near point lies at 8 inches, $\frac{1}{A} = \frac{1}{8} + \frac{1}{24} = \frac{1}{6}$. In a myopic eye the far-point corresponds to the myopia;

the eye *at rest* is adjusted for divergent rays, and its accommodative power is $\frac{1}{P}$ *minus* the myopia. If this latter amounts to $\frac{1}{12}$, and the near point lies at 4 inches, $\frac{1}{A} = \frac{1}{4} - \frac{1}{12} = \frac{1}{6}$. We distinguish : (1) The absolute range, $\frac{1}{A}$, where one eye is used. (2) The binocular range, $\frac{1}{A_1}$, where both eyes are used. (3) The relative range, $\frac{1}{A_2}$, or the range commanded while the convergence of the visual lines remains unaltered ; embracing (*a*) the *positive part*, lying within the point of convergence, and (*b*) the *negative* part, lying beyond the point of convergence. To test the relative range we may place the object at a definite distance, say 12″, and find through what convex and concave glasses it can still be clearly seen. The glasses alter the accommodation without affecting the convergence—the convex measuring the negative part of the relative range, and the concave the positive part, or the accommodative force held in reserve. To do near work comfortably the positive part should be to the negative as 3 to 2.

The region of accommodation is the distance between the farthest and nearest points of distinct vision. Thus if r lies at 30″ and p at 5″ the region is 25″. With the same range the region may vary greatly.

Refraction of the Eye.—To determine this it is necessary to have a case of trial glasses, comprising convex and concave spherical and cylindrical lenses. The rays are rendered convergent by the convex, and divergent by the concave spherical glasses. The cylindrics act like corresponding spherical glasses in one meridian, and like plane glasses (not bending the rays at all) in the meridian at right angles to this. The latter is called the *axis* of the glass. The strength of a lens is expressed by a fraction, whose numerator is one, and whose denominator is the focal length of the lens in inches; the *plus* sign being prefixed to the convex, and the *minus* sign to the concave. Thus $+\frac{1}{6}$ represents a convex lens of 6″ focus; $-\frac{1}{6}$ a concave lens of the same strength. Cylindric lenses are designated in the same way, with the addition of a c placed after the fraction. Each eye should be tested separately, the other being covered with a screen. If patient has normal acuteness of vision not improved by convex or concave glasses, he may be assumed to be *emmetropic.* If vision is below normal, and improved by concave glasses, he is probably *myopic*, and the glass which gives him the best vision ex-

presses approximately the degree of his M. If he sees best through convex glasses he is *hypermetropic*, and the glass which affords the most acute vision expresses approximately his *manifest hypermetropia;* a part of the defect, called *latent hypermetropia*, being almost always concealed by the habitual use of the accommodation. Sometimes the whole H. is latent; the patient may have normal acuteness of vision and reject all glasses, or he may even appear to see better through concave glasses, so exalted is the action of the ciliary muscle. Latent H. may always be made manifest by applying a solution of atropia (4 grs. to ℥ i.), several times before the examination; it may also be detected with the ophthalmoscope. Where vision is not much improved by glasses, or the patient is uncertain in his choice of them, *astigmatism* is to be suspected. Very often the sight cannot be raised to the normal standard with any glass, and then amblyopia is associated with the refractive anomaly. (*Vide* Diseases of Refraction.)

Field of Vision is bounded by the most eccentric points which can be perceived while visual line remains fixed upon a central point; it comprises the parts seen *indirectly*, around the central object seen *directly*. To test it place patient about 12″ from a blackboard, and have him direct the eye to be examined (the other one being covered) toward a small

dot or cross marked in centre of board. Take a piece of chalk fastened to the end of a stick, and advance it slowly from edge of board, and mark spot where it is first seen. Repeat this in every direction, and join the marks by a line. This maps out the *quantitative* field. By marking in same way the points where patient is first able to count fingers, the *qualitative* field is obtained. It is essential that the patient keep his eye fixed upon the central dot during whole examination. If vision is reduced to perception of light, patient may hold his hand 12″ in front of his eye, and look steadily toward it, while a lighted candle is used in same manner as chalk to determine limits of field; candle should be shaded with hand when carried from one point to another. The field may be concentrically or irregularly contracted, or interrupted by scotomata [Gr. σκοτος, *darkness*] or blind-spots. To test for scotomata, carry the chalk from various parts of the periphery of the field quite up to its centre, and observe whether it disappears from the patient's view at any point. Sometimes the right or left half of each field is wanting—*homonymous* or *equilateral hemiopia* [Gr. ἡμι, *half*, and οψις, *vision*]. In the normal field there is always a blind-spot corresponding to the optic disc, whose fibres are insensible to light. Each point of the field corresponds to an opposite part of the retina. There are various

instruments (*perimeters*) for measuring the field, and maps for recording it.

Perception of colors may be defective congenitally or from disease. It is easily tested by bits of paper presenting the ordinary primary colors (p. 159).

It should be observed whether visual line is directed toward object looked at or not. In former case, image is formed at yellow spot, and eye is said to have *central fixation;* in latter, image is formed on some other part of retina and there is *eccentric fixation.*

Having examined each eye separately, it is necessary to find whether the two eyes work in harmony. To do this it is essential to understand the significance of diplopia, and the action of prisms.

Diplopia [διπλοος, *double*, and οψις, vision], *or double vision.* If both visual lines are not fixed upon object, the images are formed on different parts of the two retinæ and there is *diplopia*, or double vision. For example, if right eye is fixed upon object, while left is deviated inward, the latter's image falls upon a part of retina *inside* of yellow spot and is projected *outward*, so that it is seen on left side of other image. This is *homonymous diplopia*, each eye seeing its image on corresponding side. If one eye deviates outward, conditions are reversed and there is *crossed diplopia*, right image belonging to left eye, and, *vice versa.* If one eye turns upward, its

image appears beneath that of other, etc. In short, double image always appears in direction opposite to that in which eye deviates. The images may be parallel or inclined to one another. Image of deviated eye is called *false*, that of normally-directed eye being *true* one. False image is fainter from being formed on a part of retina outside of macula, and therefore less sensitive. When images stand near together, false one is very distinct, and causes intense discomfort—when far apart, it is fainter and produces little or no annoyance, as patient soon ceases to notice it. A slip of red glass may be held before one eye to color one of the images, and so aid patient in distinguishing them. Flame of candle is one of the best test-objects. Diplopia may be constant, when there is fixed squint; or may only appear when eye is moved in certain directions, as when there is only slight inefficiency of a single muscle. Slightest form of it is where images are super-imposed and object appears surrounded by a halo. In certain refractive defects there may be two or more images formed in a single eye—causing *monocular diplopia* or *polyopia*.

Prisms.—A prism bends the rays of light in the direction of its base, according to size of its angle. If, while regarding an object, a prism is placed before one eye with its base inward, the rays from object will be deviated inward and image will be formed on retina

inside of macula; there will be homonymous diplopia. Eye will instinctively try to overcome this by rolling outward, so as to bring image again upon macula, and single vision will thus be restored, provided prism is not too strong. Prisms thus very useful for testing strength of muscles—the strongest one which can be overcome by them being taken as measure of their power. For example, if while looking at an object 12 ft. distant, a prism of 15°, with base inward, can be placed in front of one eye (or a prism of 7½° in front of each eye) before ability to fuse the double images is lost, we may consider that prism as measure of power of external recti at distance named. Thus, also, where there is diplopia, strength of prism required to fuse images becomes a measure of deviation of visual lines. For example, if there is homonymous diplopia, and images are united by prism of 15° placed before one eye with base inward, we say that there is weakness of internal recti of 15°. The eyes are able to unite double images widely separated laterally, but cannot unite those showing more than very slight difference in height. If prism of 10° base upward or downward is placed before one eye, a diplopia is thus produced which cannot be overcome: impulse for single vision is annulled and eyes yield passively to muscles which happen to be

strongest. This fact is made use of in prism-test for power of internal recti.

To examine *the action of the muscles*, patient may be directed to look at a pencil and to follow it with both eyes, without moving his head, while it is carried slowly in various directions through his circle of vision. If a muscle is inefficient, eye may often be seen to waver and lag behind its fellow when turned in direction of such muscle's action. For example, if right *externus* is weak, when pencil is moved to patient's right side the left eye will follow it, but right will not, or will do so in uncertain, faltering manner. The *internal recti* should be carefully tested as to their converging power: (1) Patient may look at pencil with both eyes while it is gradually advanced to within 4 or 5 inches, surgeon observing whether they remain fixed upon it or deviate outward. (2) While both eyes are fixed upon pencil, one may be covered by hand so as to exclude it from vision but still allow of its being watched: if its *internus* is weak it may be seen to roll outward as soon as its visual sensation is thus cut off. (3) Draw a fine vertical line upon piece of white paper and in middle of line make a round, black dot $\frac{1}{3}$ inch in diameter. Let patient hold this at his ordinary reading distance and look at it, while a prism of 12°, base upward or downward, is held before one eye. Two dots, one above other, will then be seen. If

muscles are normal, dots will be on same vertical line: if the *interni* are weak they will be separated laterally and *crossed*, that of right eye being on left side, and *vice versa:* in latter case, by placing other prisms—base inward—before eye, the dots may be brought into same vertical line; and strength of prism required for this measures deviation (or weakness of interni) which was present. If images are separated laterally, and homonymous, it shows deficient action of *externi;* prisms placed base outward before eye will bring them into same vertical line; prism required measuring the muscular weakness. Candle may be used instead of dot. Most common defect of muscular equilibrium is ordinary *squint*, which is generally discovered at a glance. (*Vide Strabismus.*) Other defects often so slight as to be very difficult of detection.

Binocular vision. [Lat. *bis*, *twofold*, and *oculus*, *eye*.] Important to know whether this exists. Simple test is to hold pencil midway between eye and print, while reading. If there is binocular vision, pencil will not interfere with view of any part of page; but if only one eye is used, the pencil will obscure view just in proportion to its size. Another test is to hold a prism before eyes, and if it produces diplopia it proves existence of binocular vision. Some eyes become so different through disease or are of such different construction con-

genitally, as to be independent organs, binocular vision having ceased or never having existed.

THE OPHTHALMOSCOPE.

When light enters eye, part is absorbed and part reflected. Reflected rays emerge precisely in direction in which they enter. To see fundus it is necessary for observer's eye to be in path of these reflected rays without intercepting source of light. This is done by the Ophthalmoscope [Gr. οφϑαλμος, *eye*, and σκοπεω, *to look*] invented by Helmholtz, 1851, which consists of plane or concave mirror for illuminating eye observed, with minute central perforation by which observer's eye can be in path of emergent rays. Many modifications of instrument have been devised, best one being that of Liebreich, as modified by Dr. Loring, of New York. Examination should be made in dark room with bright, steady light placed on level with patient's head, behind and to side of eye observed. Pupil may be dilated by weak sol. atropia (gr. j. to ℥ viij.) Two methods of examination; the *indirect* (or inverted image), and the *direct* (or erect image). In former, the surgeon holds mirror close before his eye and illuminates eye observed from distance of about 12″: with the other hand a $2\frac{1}{2}$ inch biconvex object-lens is held vertically before

observed eye, so that pupil lies about in its focus ; lens may be steadied by resting a finger against patient's forehead, and another finger may be used to raise upper lid if required. An enlarged, inverted image of fundus is thus formed between lens and observer ; image may be further magnified by using a weaker object-lens ($3\frac{1}{2}$–4″), or by placing an 8–10″ convex lens behind mirror. Optic disc is best brought into view when patient directs his eye a little toward nasal side of centre ; the macula, when he looks straight ahead. In *direct method* no object lens is used and observer approaches as close as possible, using eye corresponding to the one he examines, and relaxing his accommodation as if he were looking into infinite distance. Image is erect and apparently *behind* patient's eye ; it is larger than inverted image, but field of vision is smaller, direct method being preferable for minute and accurate examination of details, the indirect for a general survey of whole fundus.

In examining an eye with ophthalmoscope, the media should be first observed from a distance of 12–18″. If observed eye is moved in all directions, and especially if pupil is dilated also, no opacity of media need escape detection. Such opacities appear black on red background, while by oblique illumination, they have grayish aspect. Lenses affected by ordinary senile changes which may simulate

cataract under latter method, are found perfectly transparent by former. If media are clear, pupil is filled by brilliant yellowish-red reflex from retinal and choroidal vessels, more or less modified by amount of pigment present. Appearances of fundus vary greatly within limits of health. Optic papilla (*vide* p. 6) generally appears as round or vertically-oval disc, about $\frac{1}{7}$ in. to inner side of posterior pole, slightly prominent, of yellowish-white color (most marked on inner half), often bordered by pigment and by whitish connective-tissue ring, and marked by white striæ from trabeculæ of lamina cribrosa. Central vessels radiate from its centre into retina (*vide* p. 21), arteries of bright color and straight course, with light streak along centre; veins larger, darker and more tortuous. *Venous pulsation* appears on disc, or, if not, is easily produced by slight pressure upon globe. *Arterial pulsation* not observable in normal states. Near centre of disc is white, glistening *physiological excavation*, generally small and shallow, with sloping edges over which vessels are seen to dip; sometimes it is large or has sharp edges. Retina is too transparent to be easily seen; seen best in dark eyes, especially in those of negroes, where it may appear as grayish film. Macula should be looked for 2 diameters of papilla to outer side of same, and on level with its lower half; if seen at all, appears as bright-colored de-

pression surrounded by dark yellow border, and marked by absence of blood-vessels. The pigmented cells may be seen as small dots uniformly studding fundus. In light eyes vessels of choroidal stroma may be seen as bright red bands enclosing inter-vascular spaces, and even finer vessels and venæ vorticosæ may appear. In dark eyes choroidal vessels may be completely hidden, and fundus may have mosaic appearance from abundance of pigment.

In what has been said of *direct method* it is assumed that eyes of both patient and observer are emmetropic and with accommodation relaxed—that is, *adjusted for parallel rays.* Then, rays which emerge from illuminated fundus of patient's eye and enter observer's eye are parallel, and latter obtains a distinct image, although object is but two or three inches away. If eye observed is not in condition assumed, direction of the rays is altered accordingly, and image naturally indistinct. In myopia, emerging rays are convergent: a concave glass must be placed behind hole in mirror to render them parallel before entering observer's eye, in order to give him a clear image. In hypermetropia a convex glass must be similarly used. Glasses thus required to give clear image—that is, to render rays parallel, as in emmetropia, become also a measure of existing departure from emmetropia, or of the refractive-defect. If

observer is not emmetropic, he can correct his defect by proper glass, and then proceed as if he were an emmetrope. If he cannot fully relax his accommodation, he is practically myopic to amount used—that is, his eye is adjusted for divergent rays. The amount used is generally the same, and can be found by experiment. Having found this, observer should proceed as if he had myopia of that degree. In making calculations, observer's defect must always be allowed for.

Such, in brief, are the principles on which direct method becomes so useful for measuring refraction of observed eye. It is valuable aid to other means, not substitute for them. This method also used for making measurements in depths of fundus, on principle that a certain refraction corresponds to a certain length of antero-posterior axis. For full explanation of whole subject see *Mauthner's Lehrbuch Ophthalmoscopie*, chap. vi.; also, "*Determination of the Refraction of the Eye with the Ophthalmoscope*," by Dr. Loring. Dr. Loring's Ophthalmoscope is furnished with circular metal discs containing small convex and concave lenses, each running from $\frac{1}{48}$–$\frac{1}{2}$. These discs fit upon back of mirror; and by rotating them, any glass required can be brought opposite sight-hole.

Comprise both local and general means. Latter very important. Many ocular diseases result from syphilis, rheumatism, Bright's disease, gout, etc., and will not recover without appropriate general medication. Surgeon's hands and instruments should be scrupulously clean, and never carried from one eye to another without washing. Rags and brushes used on one eye should never touch another. Poultices and lead-lotions should be avoided. Latter form insoluble precipitates which may deposit in corneal tissue as white opacities. Cleanliness, good hygiene, rest of eyes, avoidance of bright light, wind, dust, smoke, etc., are prescriptions of universal application. In syphilitic disease mercurial effect should be rapid, and drug is, therefore, given by inunction, combined usually with iodide of potash. Wherever there is pain it is proper to give opiates. Following *local* means are of very extensive use :

The protective or compress bandage : Used to exclude eye from injurious influences, to support and keep it at rest. To apply it, lay small piece soft linen over closed lids, and upon this spread charpie enough to fill orbital hollow, regulating amount according to object in view, and being careful to distribute it in

such way that its pressure will be uniform. This is held in place by flannel roller, $1\frac{1}{2}$ inches wide, applied by alternating turns, first around forehead and then down under occiput and over eye, and fastened securely by pins.

Eye-shades: Often used as protection from light and wind. Best made of thick paper or pasteboard covered with black or blue silk and fastened by tape running around head.

The hermetical bandage: Sometimes needed to protect sound eye from contagious discharges of diseased one. To apply it cover eye with piece of soft linen and pad of charpie; fasten this with plaster and cover with collodion. Or, charpie may be covered with piece of oiled silk, and over this a piece of linen, the whole coated with collodion and fastened by it to skin at edges.

Local blood-letting: Accomplished by natural and artificial leeches. They are applied to temples about an inch from outer canthus, or further back among the hairs (which are first shaved), if it is necessary to hide scar. Effect of artificial leech decidedly revulsive, and vision often worse immediately after. After-bleeding from leeching encouraged by hot applications, and patient kept in darkened room for ensuing 12–24 hrs.

Cold applications: Best method of making them is to have several pieces of soft linen, about two inches square and one or two folds

thick, spread upon cake of ice. One of these can be laid over eye and changed for another as soon as it becomes heated. If *dry* cold is preferred, a small rubber bag filled with pieces of ice may be used.

Hot applications: Made by cloths wrung out of hot water, or by throwing hot water against eye with hand.

Heat and cold not to be applied continuously, but rather for periods of 10–20 minutes, at intervals of an hour or more. Cold is always proper at onset of acute external inflammations. Beyond this no absolute rules for their use, the patient's *sensations* being as safe a guide as any.

Mydriatics, or agents which enlarge the pupil. The *sulphate of atropia* (active principle of belladonna) is type of this class, and is the one used. It contracts blood-vessels and paralyzes sphincter of pupil and ciliary muscle, putting eye in state of complete physiological rest. Applied directly by being dropped from dropper into lower conjunctival fold, or pencilled upon inner surface of lower lid with camel's-hair brush. Is absorbed through cornea and conjunctiva, and effects appear in few minutes and last several days. Pupil first dilates, and then accommodation gradually becomes paralyzed, and effects pass off in same order. Form employed is solution of 1–4 grs. to water ℥i., and this is sufficient for all ordinary use. Very weak solution (gr.

$\frac{1}{8}$ to ℥ i.) will dilate pupil without paralyzing accommodation, and is thus useful for purposes of ophthalmoscopic examination. Atropinized gelatine and paper are sold, and are very convenient. Patient should always be told beforehand of effects of drug, else he will be frightened and accuse surgeon of "putting out his eyes." In some cases atropine has poisonous effect, shown by increase of inflammation, pain, irritation of lids and conjunctiva, eczematous eruption, etc., and has to be discontinued. ($\frac{1}{2}$ gr. sulph. zinc added to each ounce of sol. will often prevent this.) Rarely it may enter general circulation, causing symptoms of belladonna poisoning. Morphine is proper antidote.

Myotics, or agents which contract pupil, are of very limited application. Calabar bean is type and is about only one used locally. It contracts pupil and causes spasm of ciliary muscle. It will overcome weak sol. atropine, but not a strong one, and its effects are brief. Its active principle is *physostigmine.* Most convenient form is *calabarized gelatine discs.*

Irritants, astringents and caustics ; following used most commonly :

Powdered calomel ; applied by dusting it into eye from camel's-hair brush while lids are held apart by fingers. Brush should not touch eye, and powder should be fine and not used in excess, lest it form lumps, and cause too great irritation.

Ointments of *red*, or *yellow oxide of mercury*, or of *oxide of zinc* (each gr. 1–3 to ʒ i.): applied on inner surface of lower lid by brush, or small spatula, and spread over globe by lids.

Crystals of *sulphate of copper* (*blue-stone*) and of *alum*, cut into smooth and convenient form: *equal parts sulphate copper, nitrate potash* and *alum, moulded into sticks* (*lapis divinus*); *mitigated stick nitrate of silver:* are applied to palpebral conjunctiva by everting lids.

Solutions nitrate of silver (gr. 5–40 to ℥ i.) are applied to palpebral conjunctiva with brush, or cotton wound on stick—the excess being washed away with solution salt and water. *Lotions* or *washes* (*collyria*) for patient to use himself are usually made from *sulphate of zinc* or *alum* (gr. 1–2 to ℥ i.), or *nitrate silver* (gr. $\frac{1}{2}$–1 to ℥ i.)

For *bathing the eyes* a solution of *salt and water* (ʒ i. to Oi.) is very useful.

Where there are irritating discharges and sticking together of lids, simple cerate is given, to be smeared along edges of lids.

SURGERY OF THE EYE.

The following are the principal operations performed. The lids are held apart, when necessary, by a *spring-speculum*, and the eyeball kept in position by *fixation-forceps*,

which should grasp fold of conjunctiva near corneal margin, and be *lightly held*, so as to steady globe without any undue traction or pressure. Most of the incisions are made through cornea, and knife should always be entered perpendicularly, so as to divide tissue by shortest route and not run between its laminæ. When point of instrument has entered ant. chamber, it should be turned forward, and carefully watched lest it wound iris or lens. Incisions in ciliary region are to be avoided, on account of risk of sympathetic ophthalmia. Blood-clots, etc. best removed from incision on front of eye, by gently rubbing lids over it; or by fine forceps.

Paracentesis of cornea: performed by passing broad needle, or blade of paracentesis-knife, through cornea near margin, and allowing aqueous humor to drain off slowly alongside of instrument. In this, and all other operations where anterior chamber is opened, a too rapid escape of fluid must be avoided, through fear of prolapse of iris, and of injurious shock which results from too sudden diminution of intra-ocular tension.

Saemisch's operation for indolent ulcer [*Saemisch*, *Bonn*, 19*th cent.*], consists in passing point of a narrow-bladed cataract knife through healthy cornea, 1 mm. from one edge of ulcer, and bringing it out same distance from opposite edge; knife is then made to cut its way out through bottom of ulcer.

Incision kept open by passing fine probe through it every day or two, and ocular tension so kept down until process of repair begins.

Iridectomy [Gr. ιρις, and εκτομη, *cutting out*]. The lance-shaped knife is entered through cornea near its edge, carried on until incision is of desired length and then withdrawn. Iris-forceps then passed through incision, made to grasp iris and draw it out, when desired amount is cut off by scissors close to lips of wound.

Iridodesis [Gr. ιρις, and δεω, *to bind*]. A small iridectomy-incision is made and over this is laid loop of fine silk. Iris is caught by blunt hook and pulled out through incision and loop. Ends of latter then pulled and tied. Tissue thus strangulated drops off in 24–48 hrs. generally. Sometimes no loop is used, iris being merely left caught between lips of wound. Operation now seldom performed.

Iridotomy [Gr. ιρις, and τομη, *section*]. Performed where iris has formed cicatricial adhesions anteriorly and pupil is closed by inflammatory deposit. Knife is passed through cornea and small slit made through iris, edges of which retract naturally, leaving a permanent opening to serve as new pupil. Sometimes iris is picked up by forceps.

Corelysis [Gr. κορη *pupil*, and λυσις, *loosing*]. Performed to break up adhesions which have

formed between edge of pupil and capsule of lens. Iridectomy-incision is made at corneal margin, a little to one side of adhesion which it is proposed to loosen. Blunt, flattened hook then passed in and made to tear through attachment.

CATARACT OPERATIONS.

Keratonyxis [*κερας*, *cornea*, and *νυσσω*, *to puncture*], or *solution of cataract*. Applicable only to soft cataracts. Consists in lacerating anterior capsule by fine needle passed in through peripheral portion of cornea. Aqueous humor thus comes in contact with lens matter and softens it so that it is gradually absorbed. Operation generally has to be repeated several times. Best to lacerate capsule and lens very slightly, especially at first sitting, else great swelling of lens-matter may result, causing injurious pressure. Pupil should be dilated with atropine before operation. Soft cataracts also removed through *linear incision* made at edge of cornea; may escape spontaneously as soon as wound is completed or require to be *coaxed out* in same manner as hard cataracts, or to be removed by curette. When there is undue swelling of lens after keratonyxis it should be evacuated at once through a linear incision.

Flap extraction is designed for removal of hard cataracts. Section is made either up-

ward or downward at margin of cornea, so that about half cornea is comprised in flap. Capsule next opened by cystotome. Then gentle pressure is made with finger or a curette against globe opposite flap, so as to tip edge of lens forward into wound through which it escapes.

Graefe's modified linear extraction [*Albrecht Von Graefe, Berlin. Died*, 1870] is most common operation for hard cataract. Incision is smaller than in flap-operation, and regulated by size and hardness of lens. To make it, the point of a narrow-bladed knife is passed through sclero-corneal junction at upper part of cornea, carried across anterior chamber and out at corresponding point on opposite side. Edge of knife is then turned obliquely upward and forward, and by sawing motion made to cut its way out. A piece of iris is drawn out and excised. Capsule is divided by cystotome. Lens is tipped forward into track of wound by pressure with curette at lower corneal margin; then by gently sliding curette up over cornea, lens is forced out.

Liebreich's operation [*Liebreich, London, 19th cent.*]. Incision is made with narrow-bladed knife, is more transverse than in Graefe's operation, and lies wholly in cornea, except puncture and counter-puncture, which are made in sclerotic about 1 mm. from its edge. No iridectomy is performed.

During all operations involving corneal incision, iris may fall forward into wound, and if it cannot be replaced, the prolapsed part must be snipped off with scissors. After escape of lens a few drops of vitreous may follow, but if eye is closed and bandaged at once no bad result usually ensues.

Strabismus-operation: Tenotomy.—A fold of conjunctiva and sub-conjunctival tissue is seized by forceps near margin of cornea and a little below middle of insertion of tendon to be divided. This fold is snipped by blunt-pointed scissors which are passed through opening and by a burrowing motion made to divide sub-conjunctival tissue enough to expose tendon. Strabismus-hook is inserted and passed under tendon so as to catch it up, after which it is brought into view by pushing aside conjunctiva. While held on hook, it is divided by scissors close to its insertion. Another hook is then inserted and moved freely around, and any remaining fibres caught up and divided in same way. Conjunctival wound may be closed by sutures if desired. No dressing required, as a rule.

Advancement of insertion of a muscle.—Vertical incision is made in conjunctiva, 1–2 lines from edge of cornea. Tissues, including muscle (whose insertion is first divided), are dissected up down to sclerotic and as far back as equator. Flap thus formed is pulled forward and united by sutures to flap left

standing at corneal margin. If some conjunctiva is excised before bringing flaps together, effect is increased. Tendon of opposite muscle usually divided also, to increase effect.

Bowman's operation for opening the canaliculi [*Bowman, London,* 19*th cent.*]. A fine director is passed into punctum and along canaliculus into sac, its groove turned toward free margin of lid, which is kept tense by being pulled outward with finger. Point of narrow-bladed knife then inserted into punctum and passed along director so as to lay open canal quite up to sac. Or a narrow, probe-pointed knife is passed into punctum and along canaliculus and made to divide this by raising it from heel to point, no director being used.

Probing the nasal duct is done by Bowman's probes, which are of different sizes and bent to correspond with course of duct. Edge of lid is kept on the stretch as before. End of the probe is passed along divided canaliculus until it is felt to strike hard inner wall of sac. It is then raised into vertical position, with convexity of its bend backward, and passed downward through sac, and then downward, outward and forward through duct into nose. When end of probe is *not in sac*, each movement of it will be seen to cause a movement of overlying skin.

Canthoplasty. Division of outer canthus. —Pass one blade of strong scissors behind

commissure to bottom of *cul-de-sac*, and other in front, and divide commissure by one sharp cut, incision being exactly horizontal. Conjunctival surfaces of wound then joined to cut edges of skin by three or four fine sutures, one above, one below and one at outer angle being usually sufficient. After making first incision some recommend to put upper lid on stretch by pulling it toward nose and to divide upper canthal ligament by a nick with scissors, at right angles to incision, nick being made about two lines from temporal border of orbit.

Enucleation or excision of eyeball: Conjunctiva seized with forceps and divided all around cornea quite close to its edge, by circular incision, with blunt-pointed scissors, curved or flat. Tendons of muscles picked up successively by strabismus-hook and divided close to sclerotic. Eyeball then drawn over to one side by forceps, and scissors (with curve towards eyeball) passed back along its surface to optic nerve. Blades then opened and made to divide nerve close to sclerotic. Hemorrhage generally slight, and ceases if lids are closed and cold compresses applied. Packing orbit with sponges, ice, etc., usually needless. By this operation orbital tissue and muscles are left behind to form good, movable stump for artificial eye.

Artificial eyes may be worn after wound has cicatrized and all irritation ceased. Should be worn at short intervals, at first,

until parts become used to the foreign body. If *sympathetic trouble has existed in other eye* no artificial eye should be allowed for several months.

CHAPTER III.

DISEASES OF THE EYE.

ORBIT.

THE ORBIT has close relations, through membranes and vessels, with nose, antrum, cranial cavity, and temporal fossa. Its diseases, therefore, are not always independent. They are not usually limited to a single tissue, but so classified for convenience. The symptom common to many orbital diseases is *exophthalmos* or *protrusion of the eyeball.* It may be hardly perceptible, or so severe that lids cannot close, and exposed cornea sloughs and allows contents of eye to escape. *Rarely* globe may be forced entirely out and lie upon cheek. With protrusion there is redness and œdematous swelling of conjunctiva and lids, mobility of globe is impaired, and nerves may be paralyzed from pressure. Vision is impaired according to tension and pressure upon optic nerve and ocular tunics.

INJURIES: Generally due to incised or punctured wounds or to foreign bodies. May

cause orbital abscess, periostitis, hemorrhage, emphysema, fracture of bony walls, injury of eyeball, and even extrusion of it. Results may appear at once, or *not until some time after accident.* Fractures of roof and inner wall very dangerous from injury to brain. Foreign bodies should always be removed if detected. Best place for incision, either for exploration or removal, is through conjunctiva, between eyeball and lid. Outer canthus may be divided to give more room for manipulations. Parts should be kept at rest, and cold and leeches used to check inflammation. If eye is extruded it may be replaced and compress bandage applied. Incised and punctured wounds treated as in other parts.

PRESSURE UPON ORBIT, with tumor at upper inner angle, and displacement of eye downwards and outwards, is sometimes caused by distention of frontal sinus. Tumor, if left to itself, may burst into nose, orbit, or through upper lid.

EMPHYSEMA: Usually from fracture ethmoid cells or frontal sinus, or rupture lachrymal sac. Air enters cellular tissue of orbit and lids, causing elastic, crepitating swelling, and exophthalmos. Generally disappears under gentle pressure.

HEMORRHAGES: Chiefly from injury; sometimes spontaneous or due to straining. Ecchymosis may appear in lids and under con-

junctiva some time after accident. May cause exophthalmos and injurious pressure. Best treatment to encourage absorption by cold compresses and firm bandage. Incisions where symptoms are urgent.

Abscess; Orbital Cellulitis: Caused by wounds, foreign bodies, disease of bone, cold, operations on eye, extension of inflammation from other parts, severe constitutional disease. Symptoms almost always acute, reaching crisis in 8–14 days. Lids red, hot, and swollen; intense pain, increased by pressure against globe; fever, and perhaps brain-symptoms. Exophthalmos generally directly forward. Sight may be impaired from pressure on optic nerve, which may cause engorgement and neuritis. When pus forms, fluctuation may be found behind lids, and abscess may burst through lids or conjunctiva. Prognosis guarded, on account of possible necrosis, meningitis, and permanent injury of vision. Antiphlogistics in early stages; if suppuration occurs, poultices, and incision through conjunctiva between lids and globe. Exploratory incision is proper when in doubt about pus, and it is always better to use knife too early than too late.

Inflammation of Tenon's Capsule occurs very rarely. Caused by cold, strabismus operations and ophthalmitis. Produces pain; swelling and redness of conjunctiva, and, to less extent, of lids; with perhaps slight ex-

ophthalmos. Leeches and ice-compresses may be used in early stages.

PERIOSTITIS is generally limited and due to cold, injury, foreign bodies, or is secondary to inflammation of other parts. In *acute* form there is severe pain and *local tenderness on pressure against bony wall.* Swelling and redness of lids and perhaps slight exophthalmos—generally towards one side. Sometimes fever. Pus may form beneath periosteum, and necrosis may result. General treatment is that of cellulitis. In *chronic* form, which is generally due to syphilis, symptoms are less marked. Pain apt to be worse at night. Nodes and exostoses may develop. Treatment should be that for syphilis.

CARIES AND NECROSIS result from injury, periostitis, cellulitis, syphilis, tuberculous and scrofulous cachexiæ. Cause sluggish, œdematous, inflammatory swelling of lids, which points and discharges foul pus. Fistulous opening marked by unhealthy granulations, and dead bone may be felt by probe. Pus should be evacuated as soon as possible and opening enlarged, when necessary, for removal or escape of exfoliated bone. Sinus should be kept open and clean until it can heal from bottom. In healing process there is apt to be cicatricial contraction of lid, leaving severe ectropion.

TRUE ANEURISM may arise from ophthalmic artery or its branches, causing protru-

sion and pulsation of globe. Pain generally slight.

DIFFUSE OR FALSE ANEURISM much more frequent. Caused by rupture of artery from injury or disease with sudden escape of blood into orbital tissue. May supervene upon true aneurism. There is immediate pain and exophthalmos. Latter increases, with redness and swelling of globe and lids; and elastic pulsating tumor appears at edge of orbit. Pulsation stopped by pressure on carotid. Whirring noise in head, audible with or without stethoscope. Only treatment for true and false aneurisms is by compression or ligature of carotid.

ANEURISM BY ANASTOMOSIS: rare; generally congenital and found in children. Most often situated in subcutaneous tissue of anterior part of orbit. Consists of group of dilated arteries forming irregular, doughy tumor with pulsation and thrill—not much affected by pressure on carotid. Best treatment is by subcutaneous ligature or electrolysis.

TUMORS of orbit are of same kind, benign and malignant, as are found in other parts of body. May arise in orbit or invade it from eyeball or from neighboring parts. Cause exophthalmos, and its injurious consequences. Malignant tumors are of more rapid growth than benign, and involve general health. Tumors should be excised, when there is any prospect of benefit from operation—if possible

without sacrificing eyeball. It is often necessary, however, to remove latter also, even when considerable vision remains to it.

A form of exophthalmos of both eyes, without much loss of vision, associated with cardiac disturbance and enlargement of thyroid gland, occurs in *Basedow's* or *Graves' disease* or *Exophthalmic Goître.*

CONJUNCTIVA.

FOREIGN BODIES upon conjunctiva cause marked irritation, congestion, and lachrymation, or flow of tears. [Lat. *lacryma*, *tear*]; together with spasmodic closure of lids, pain and *gritty* sensations. May be washed away by free flow of tears excited, or require removal. Ocular and palpebral conjunctiva must be thoroughly exposed and examined,—by magnifying glass if necessary (*Vide* p. 41). Foreign body easily removed by bit of soft cloth; or, if deeply embedded, by spud or forceps.

Sand, bits of broken glass, etc., may be washed away by stream of lukewarm water. *Sensation of foreign body may persist for some time after its removal.*

Injuries from lime, *mortar*, *acids*, *hot fluids etc.*, cause excoriation, sloughing; and, in healing, cicatricial contractions. Eyes should be carefully washed with warm water, and soothing applications made—olive oil being

very useful one. If patient is seen at once, lime may be neutralized by vinegar and water (ʒ i. to ℥ i.); acids by solution of soda (i. to ℥ iv.). After-effects treated *pro re nata*. Astringents to be avoided where excoriations exist.

ECCHYMOSIS : occurs from rupture of vessels by injury, or violent exertion, such as sneezing ; during scurvy and Bright's disease ; in course of inflammations ; without any apparent cause ; or may extend forward from orbit,—usually some time after accident. Treatment by cold water, or slightly stimulating lotion (*Tinc. arnicæ* ʒ i., *Aquæ* ℥ iv.)

ŒDEMA : frequent in inflammation ; occurs spontaneously in debility, old age, kidney-disease. Compress bandage and mild astringent wash.

Change & yellow fever in eye ball.

EMPHYSEMA : occurs, rarely, from fracture of nose or rupture lachrymal sac. Causes crepitating swelling. Pressure bandage.

CONJUNCTIVITIS : *inflammation of conjunctiva :* Divided for convenience into several varieties :—

(1) *Catarrhal.*
(2) *Purulent.*
(3) *Gonorrhœal.*
(4) *Diphtheritic.*
(5) *Granular.*
(6) *Phlyctenular.*

Classification is arbitrary ; one form may run into another ; and discharge from one

form may reproduce that form or a different one. All varieties are contagious and infectious, and may occur epidemically. Differential diagnosis often impossible at first.

Catarrhal Conjunctivitis: Catarrhal Ophthalmia: Mildest form. Caused by injuries, exposure, bad hygiene, exanthematous diseases, &c.; may be secondary to other inflammations; in rare cases appears due to errors of refraction. *Symptoms:* Smarting, itching, sensation as of sand in the eye, lachrymation; increased vascularity, causing partial or uniform redness of globe and giving to inner surface of lids rough, velvety appearance: œdematous swelling of membrane and subjacent tissue, *chemosis*, [Gr. χημη, *a gaping?*] which, if severe, may rise above level of cornea causing it to appear sunken: redness, swelling and stiffness of lids; mucous or muco-purulent discharge, with tendency to gluing together of lids, especially in morning. Usually attacks both eyes at once. Amenable to treatment, and not very apt to invade cornea.

Treatment: In this (and in all other forms) extreme cleanliness as regards patient, and all towels, utensils, etc., used by him, with isolation if necessary; hygienic precautions and attention to general health. Locally, mild astringent lotion every few hours, such as zinc. sulph. gr. ii. to aquæ ℥j. Cold applications in early stage.

Purulent Conjunctivitis: Blenorrhœa: Egyptian, contagious, or military ophthalmia: Like last variety, with all symptoms intensified, and due to same causes. Often appears as epidemic in workhouses, barracks, &c., where people are crowded together. Discharge purulent, thick, very contagious. Great danger of invading cornea, causing ulceration, sloughing, and, perhaps, loss of eye in short time.

Treatment: mild cases treated as catarrhal form. Severe ones should be isolated in darkened room. If only one eye is affected, other should be hermetically closed. Cold, leeches, division of outer commissure (canthoplasty) if lids press severely against globe; scarification of conjunctiva, if great swelling and chemosis. When discharge is thoroughly established, astringent lotion every few hours, and application of strong solution or mitigated stick nitrate of silver to inner surface of lids once or twice daily: cold compresses may be continued or changed for warm ones if more agreeable to patient. Strong solution atropine if cornea becomes at all clouded.

Gonorrhœal conjunctivitis: gonorrhœal ophthalmia. Does not differ, except in manner of origin, from any other purulent conjunctivitis. An extremely virulent, purulent inflammation, caused by inoculation from urethral discharge. May destroy eye in few hours. If patient is seen immediately after

inoculation, syringe out eye with warm water, apply 2 gr. solution nitrate silver, and ice compresses, in hope of aborting attack. If disease is established, treatment is same as in last form.

Conjunctivitis in newly-born: Ophthalmia neonatorum [Gr. νεος, *new*, and Lat. *natus*, *born*]: catarrhal or purulent conjunctivitis of infants, usually appearing shortly after birth, and caused by contact with vaginal discharges of mother; may also occur from other causes, as exposure, filth, &c., and not appear until several weeks after birth. All grades of severity.

Treatment: same as in similar inflammations of adult, regulated by severity of attack. It is believed by many that, in these cases, nitrate of silver is needless and injurious; and that a solution of alum gr. ij. ad ℥ j. is a sufficient astringent application.

Diphtheritic conjunctivitis: Occurs in course of diphtheria, and also results from same causes as other forms. Begins with great heat, redness, swelling, and *tenderness* of lids, with rigidity *from fibrinous infiltration.* Firm swelling of conjunctiva from same cause, and pale, smooth, glistening appearance of its surface. Sometimes grayish exudation-membranes on conjunctiva, which may be stripped off. Discharge of flakes of lymph. Advanced stage marked by softening of parts, from disappearance of fibrinous

matter, and discharge of pus. Great tendency to shrinking and cicatrices of conjunctiva in healing. Cornea apt to suffer. Constitutional disturbance often marked. Disease rare in the United States and England. *Treatment* not very effectual. Ice-compresses, leeches, &c., in first stage. Astringents, and caustics in purulent stage. Atropia throughout. Support of general system.

Granular conjunctivitis; Granular ophthalmia; Granular lids; Trachoma: Generally a result of one of the above-described inflammations, and essentially a chronic condition, although sometimes associated with acute symptoms. Granulations almost entirely confined to palpebral conjunctiva, and of two kinds: (1) Enlarged conjunctival papillæ; (2) "Frog-spawn granulations," grayish bodies, looking like sago-grains, and composed of lymphoid cells and connective tissue. Both varieties may be seen separately, but more often mingled. Symptoms those of annoying chronic conjunctivitis, more or less severe. If process not checked, cornea falls into state of ulceration and vascularity, from constant friction of rough lids upon it; conjunctiva and tissues of lids may become atrophied and cicatricial, leading to entropion, symblepharon, xerophthalmia, etc. Disease generally associated with low general health, and bad hygiene. Runs tedious course. *Treatment:* Locally, astringents and caustics—sulphate of

copper crystal being a favorite one. Nitrate of silver, oxide mercury ointment, solutions tannin and glycerine, etc., also useful. Application loses effect after a time, and may be changed for another.

Phlyctenular conjunctivitis [Gr. φλυκταινα, *pimple*] : Characteristic of this form is small, yellowish-red elevation, or *phlyctenula*, on whose summit a serous vesicle forms, which bursts and leaves a small ulcer. One or several of these bodies may be present; they are generally situated near margin of cornea, and run course in eight or ten days. The conjunctival congestion may be general, or partial—a triangular leash of vessels running up to each phlyctenule, its base pointing toward the retro-tarsal fold. Appearance of phlyctenulæ preceded by burning pain, photophobia or dread of light [Gr. φως, *light*, and φοβος, *fear*,] and lachrymation. Often associated with phlyctenular keratitis. (p. 89). Relapses very common.

Treatment: Particular attention to general health. Locally, atropine: application of mild irritant, such as calomel or oxide mercury ointment, after acute symptoms subside.

PTERYGIUM [Gr. πτερυγιον, *a little wing*] : Results from inflammation, and from constant exposure, such as is experienced by sailors, residents in tropical climates, on the Western prairies, etc. Consists of hypertrophy of con-

Fr. Cases curable by medicine not very frequent.

Thoroughly eradicated rarely returns

junctiva and sub-conj. tissue, forming triangular, vascular prominence, generally at nasal side of eye, with base toward inner canthus, and rounded apex at edge of cornea, or encroaching more or less upon latter. Called pterygium *tenue* [Lat. for *thin*], or *crassum* [Lat. for *thick*], according to its thickness. Requires no treatment unless it extends upon cornea so as to obstruct vision. May then be removed by (1) *Excision;* performed by dissecting growth off from cornea and sclerotic to a point near canthus, and uniting conjunctival wound by sutures. (2) *Transplantation;* performed by dissecting it off up to base, and then inserting it into an incision made in conjunctiva parallel to lower edge of cornea, retaining it there by sutures. Or (3) *Ligature;* by thread passed around growth at two or more points, and tied, so as to cause strangulation. If preferable, a new pupil may be made by iridectomy opposite clear part of cornea.

XEROPHTHALMIA, or DRYNESS OF THE EYE [Gr. ξηρος, *dry*, and οφθαλμος, *eye*]*:* generally results from severe chronic conjunctivitis. Condition one of atrophy and cicatricial change in cornea, conjunctiva and sub-conjunctival tissue; the surface being of dirty greenish or grayish color, and tendinous appearance; and dry, scaly, and stiff from destruction of secreting apparatus. Obliteration of palpebral folds and more or less ad-

hesion of lids to globe. *Treatment* inefficient. Dryness may be alleviated by bland wash, such as milk or glycerine.

SYMBLEPHARON [Gr. συν, *together*, and βλεφαρον, *eyelid*]. Adhesion between conjunctiva of lids and globe. Generally results from injuries, which have caused excoriation and sloughing, or from long-continued inflammation. Adhesion may be complete, or only partial, in form of small bands or bridles. Very difficult of cure; surfaces are separated and attempt made to keep them apart, but almost impossible to do so.

ANCHYLOBLEPHARON. [Gr. αγκυλωσις, *stiffening*, and βλεφαρον, *lid*.] Adhesion between edges of lids. Has same causes as symblepharon, and generally associated with it. Requires same treatment.

TUMORS OF CONJUNCTIVA.

Pinguecula. [Lat. *pinguis*, *fat*.] Small, yellowish tumor, of fatty appearance, situated near corneal margin and chiefly seen in old people. Consists of hypertrophied conjunctiva and epithelium. Harmless. May be excised if desired.

Dermoid tumors. Smooth, yellowish tumors, covered with conjunctiva and, perhaps, short hairs. Composed of connective tissue and fat. Generally congenital. Excision is proper treatment.

Warts, similar to those on prepuce, may occur on any part of conjunctiva. Snipped off with scissors.

Syphilitic Ulcers and Cancer occur rarely (p. 141).

CORNEA.

Injuries and Wounds: Are of various kinds. The primary treatment in all is to put the eye at rest and allay irritation by soothing applications. Atropine should be applied several times daily and cold compresses, if reaction is severe. Where epithelium is abraded a few drops olive oil useful to lubricate parts and allay pain. Compress bandage may be used to restrain motion of lids and exclude light. Beyond this, treatment must be adapted to special requirements of case.

Foreign bodies: Very frequent occurrence, most common being particles of metal, dust, glass, gunpowder, etc. Cause severe reaction according to depth to which they penetrate and time they are allowed to remain. (*Exceptionally* foreign body remains for indefinite period, causing no disturbance.) Generally easily seen by simple inspection or oblique illumination. If superficial, may be removed by spud; if firmly embedded, by needle or fine forceps. When there is danger of foreign body falling back into anterior chamber dur-

ing efforts at removal a broad needle is sometimes passed into chamber so as to press upon foreign body from behind, and support it as it is being extracted. While removing foreign body eyeball may be steadied as follows: stand behind patient, with his head against your chest; have him look downwards, and press tip of your forefinger against sclerotic just above cornea, and tip of middle finger of same hand against sclerotic below and a little to inner side of cornea. Or lids may be held apart by speculum and eyeball steadied by fixation forceps. Ether sometimes required. In some cases it is found useful to remove a small circular piece of the cornea, including the foreign body, with a trephine.

Injuries from chemical agents, burns, etc.: Apt to cause sloughing and permanent opacities. To be treated as similar injuries of conjunctiva (p.77).

Abrasion of epithelium: Readily seen as roughened, glistening facet. Very painful. Frequent cause is scratch from finger-nail.

Wounds: Chiefly dangerous from injury to deeper parts, which may fall forward (*prolapse*) into wound or escape altogether. Contused wounds apt to cause suppuration. Incised wounds generally heal readily.

KERATITIS [Gr. κερας, *cornea*]: INFLAMMATION OF THE CORNEA: Results from injuries, exposure, constitutional disease, mal-nutrition, inflammation of adjacent parts, etc. May

involve part or whole of membrane. Leads to vascularization, cell-proliferation, and suppuration, each of these phenomena being more or less prominent, according to kind of inflammation present. Attended by impaired vision, ciliary irritation, rosy zone congestion around corneal margin, pain, photophobia, lachrymation, contraction of pupil, and more or less conjunctival congestion. Cornea rendered turbid, swollen ; and, if there is ulceration, it becomes thinned, or gives way and allows deeper parts to prolapse or escape. If thinned or softened it is apt to bulge forward from intra-ocular pressure, forming *staphyloma* (p. 97). After recovery indelible opacities and alterations of curvature may remain with corresponding loss of vision. In *treatment* of active corneal inflammation it is cardinal rule *to avoid all irritants and caustics*, and to pay special attention to hygiene and general health. Atropine, rest of eyes, and protection from bright light always appropriate. Cold and leeches may be tried if symptoms very acute. When disease becomes chronic, and irritation subsides without clearing up of opacity, irritants such as calomel may be cautiously tried to hasten cure. When photophobia is severe and obstinate, canthoplasty (p. 70) is very useful.

Vascular keratitis; keratitis vasculosa; characterized by superficial infiltration and grayish cloudiness of cornea with network of

vessels traversing affected region. Epithelium may be shed, causing superficial ulceration and great pain from exposure of nerves. Under favorable circumstances tends to recovery. May run into one of other forms or be combined with them.

Phlyctenular keratitis: Herpes of the cornea: characterized by *phlyctenules* in superficial layers of cornea, like those of phlyctenular conjunctivitis; and often associated with latter disease. Phlyctenules appear as inflammatory nodules, singly or in groups, on any part of cornea, but most often at margin; may be surmounted by vesicles which burst and leave small ulcers, or ulcers may result from loss of tissue of nodule without formation of vesicles. When eruption is limited, attendant congestion is partial; a triangular network of vessels is seen running towards phlyctenule, its base toward retro-tarsal fold and its apex at phlyctenule, if this is at edge of cornea. If phlyctenule lies some distance from edge of cornea, apex of triangle appears cut off at latter—a space of clear tissue intervening between it and phlyctenule. If disease is severe, vascular keratitis may supervene, vessels extending upon cornea quite up to phlyctenule. Pain and photophobia generally marked; latter symptom often being out of all proportion to amount of inflammation. Secretions from eye irritate and excoriate parts over which they flow. Disease most common

among weak, nervous, and badly-nourished children. May arise from irritations of ciliary nerves, either directly or through fifth pair. Seen in conjunction with eruptions of herpes, eczema, etc., in course of trifacial; in conjunctivitis and nasal catarrh. In treatment, these eruptions and catarrh should receive special attention.

Interstitial, parenchymatous or diffuse keratitis: Is marked by inflammatory cell-proliferation extending through deeper layers of cornea, causing swelling and diffuse cloudiness. Latter generally begins at margin and advances towards centre; rarely the reverse; varies in degree from slight haziness to dense opacity, like that of ground glass; generally of grayish color; may be thicker in some parts than others, causing white or yellowish patches. Surface may retain its polish, but, as a rule, soon assumes dull, stippled appearance from loss of epithelium, and may become vascular. Vessels generally appear in substance of cornea running from margin toward centre. May be so numerous as to cause bright red color, like that of an extravasation. Very little tendency to ulceration. Course of disease apt to be tedious, but after duration of many months cure may be complete. Often seen in inherited syphilis.

Suppurative keratitis: In this form inflammatory infiltration becomes changed into pus, which appears as yellow opacity in cor-

neal tissue. Suppuration may be limited, or entire cornea may be changed into yellow, necrosed mass. If suppuration is enclosed by corneal tissue it forms an *abscess*; if superficial, an *ulcer*. Sometimes sinks down between layers to lower margin of cornea, presenting appearance called *onyx* [Gr. ονυξ, *nail*], or *unguis*, [Lat. for *nail*,] from resemblance to lunula of finger-nail. If pus breaks through into ant. chamber, it forms *hypopion*, (p. 126). By oblique illumination, and looking at cornea in profile, it is generally easy to distinguish between onyx and hypopion. Sometimes both coexist. Suppurative process may be attended with vascularity and very acute symptoms, or there may be no vessels, and little or no irritation. Latter form specially dangerous from rapid death and sloughing of tissue. Abscesses may be absorbed or burst open, or pus may undergo fatty or chalky degeneration, leaving dense opacity. When abscess opens, an ulcer results. *Ulcers* also occur superficially without precedent abscess. Are of variable size, shape and depth, and dangerous, according to situation and course. A very dangerous form is the crescentic marginal ulcer, which shows tendency to encircle cornea and cut off nutrition of central parts. In small ulcers, extending to Descemet's membrane, latter may bulge forward through ulcer like a vesicle, forming *keratocele* or *her-*

nia of cornea. Perforation generally follows. Larger ulcers frequently lead to staphyloma (p. 97). If ulcer goes on to perforation, there is sudden escape of aqueous humor, which is apt to carry iris forward into wound where it may become firmly adherent during healing of ulcer, forming what is called *anterior synechia* [Gr. συν, *together*, and εχω, *to hold*]. If perforation is large, iris may protrude through it, and become adherent around its edges, leaving staphyloma (p. 97). Sometimes after healing of ulcer, reaccumulation of aqueous humor and action of pupillary muscles are sufficient to tear loose the adhesions of iris, and allow it to fall back into proper place. Lens may also be carried forward with the iris against the perforation, and when it returns to its position it is apt to carry with it some inflammatory deposit on its anterior capsule, forming *ant. capsular cataract*. Adhesions of iris and lens to post. surface cornea may be so extensive and firm that ant. chamber is never re-established. Where sloughing of cornea is very extensive or total, escape of lens and vitreous, and atrophy of globe, may result. Ulcers may be filled up by transparent tissue and heal, without leaving trace. Slight, superficial cloudiness may remain, which gradually clears up ; or permanent, white, tendinous cicatrix may be left. During healing-process, vessels appear running over cornea to ulcer. Suppura-

tive inflammation may result from same causes as other forms. It is dreaded result of operations involving corneal incision, especially in old and feeble. Bruised and lacerated wounds apt to cause it. One of the dangers of severe conjunctivitis; occurs in paralysis of fifth pair, as *neuro-paralytic ophthalmia*. Such paralysis renders cornea anæsthetic, and so insensible to action of external irritants, and seems also to exercise bad influence upon its nutrition.

Chief treatment, besides ordinary means, consists in reducing intra-ocular pressure by paracentesis and iridectomy. This is more important than evacuating pus, which need not be attempted, except in case of hypopion. Paracentesis may be performed every day if necessary. In asthenic form of suppuration there is danger of rapid death of tissue, and hot applications may be used with view to exciting vascularity. In neuro-paralytic form it is necessary to protect cornea by bandage. In deep ulcers it is better to perform paracentesis through their base than allow spontaneous perforation. In indolent superficial ulcers Sæmisch's operation sometimes succeeds.

PANNUS [Lat. *pannus*, *a cloth*]:—is, strictly speaking, a non-inflammatory, superficial, vascular opacity of cornea—a neoplastic formation left by preceding inflammation. The term, however, is also applied to acute and chronic vascular keratitis, where formation of

new tissue is still in progress. Disease may involve part or whole of cornea. Slight grade is called *pannus tenuis*, severe one, *pannus crassus* (p.84). In extreme degrees cornea may have red, fleshy appearance. Disease may continue for months or years without marked change. Complete cure may occur, but is rare. As a rule, opacities are left, and sometimes cornea is completely covered by thick, dry, tendinous membrane. May become thinned and bulge forward. Most frequent cause of pannus is trachoma ; and corneal surface may then present granulations like those on lids. May be traumatic from long-continued irritation, such as that from foreign bodies, inverted cilia, exposure to atmosphere, etc. Treatment aims, after removing cause, to hasten resolution of opacity. For this, irritant powders and ointments are used if no inflammation exists. Sometimes remedies lose effect and have to be changed or intermitted. As last resort in desperate cases, inoculation with blenorrhœal matter may be tried. This produces severe purulent inflammation under which pannus may clear up. Best pus to use is that from ophthalmia neonatorum. A drop of this may be applied to eye, and in a few hours purulent conjunctivitis usually results, which is allowed to run its course unchecked. Inoculation only admissible where whole cornea is involved in high grade of pannus ; and greater the vascu-

larity, better the chances of success. Ulcers contra-indicate operation. Where fellow-eye is sound, it must be hermetically closed. Inveterate cases sometimes treated by operation of *Syndectomy*, which consists in removing a strip of conjunctiva and sub-conj. tissue all around edge of cornea so as to cut off blood supply from latter.

OPACITIES are frequent result of corneal inflammations with cicatricial deposit. Practically, divided into *superficial* and *deep*; former affecting epithelial layer, latter the parenchyma. Faint, superficial opacity called *nebula* [Lat. for *fog*]. Thick dense one, *leucoma*, [Gr. λευκος, *white*]. Cicatrix, combined with prolapse and adhesion of iris, is called *leucoma adherens*. White chalky-looking incrustations may result from metallic deposit, as where lead-lotion has been applied to an ulcerated cornea (p. 60). Opacities impair vision according to situation and according to alteration of curvature accompanying them. May necessitate constant straining for vision of small objects, leading to myopia and strabismus. If they prevent distinct retinal impressions, eye may become amblyopic from disuse and deviate outward (p. 137). In children, may cause nystagmus. Many opacities disappear spontaneously, especially in young, healthy subjects. As a rule, the more recent and superficial the opacity, the better the chance of

its removal. Irritants, such as calomel, are used to assist absorption by exciting hyperæmia and increased tissue-change. Lead-deposits sometimes scraped off with knife in hope that resulting ulcer will be filled up with transparent tissue. Where opacities resist all treatment and obstruct vision one of the operations for artificial pupil may be performed. New pupil should be made opposite part of cornea that is most transparent and of most correct curvature. Where small part of clear cornea remains over pupil, vision may often be improved by *stenopæic spectacles* [Gr. *στενος*, *narrow*, and *οπη*, *hole*] which cut off lateral, diffused rays of light. They are made of metal or ground-glass plates with small central slit or hole. They contract visual field greatly and can only be used for close work. Unsightly white opacities which cannot be removed are sometimes tattooed with India ink for cosmetic effect. Operation is done with number of fine needles bound together on a stick so that points project evenly: thick paste of India ink is spread over opacity and pricked into its superficial layers by needles, as in ordinary tattooing. [Diffuse cloudiness of cornea sometimes results from derangement of corneal elements by increased intra-ocular pressure. In certain diseases, such as serous iritis, irido-choroiditis, etc., fine punctate opacities are deposited on posterior surface of cornea.]

CICATRICIAL STAPHYLOMA [Gr. σταφυλη, *bunch of grapes*] :—generally the result of ulceration. Floor of corneal ulcer very apt to yield and bulge forward from intra-ocular pressure. During healing-process, bulging part is covered over with cicatricial tissue, and bluish-white protrusion, or staphyloma, is left. To this, iris may be partially adherent posteriorly. Or, if perforation occurs, iris may prolapse, close the wound, protrude through it, and form basis for the cicatricial deposit. Staphyloma may be partial or total, involving whole cornea. If partial, tendency is to increase. Lens may retain its position, or fall forward and press against post. surface of protrusion. Walls of staphyloma may be very thin and may burst; or may gradually thicken from fresh inflammatory deposit. Repeated attacks of inflammation and ciliary iritation may occur and lead finally to sympathetic trouble, especially where iris is involved and in state of constant tension. Staphyloma sometimes results from wounds of cornea and from cataract-incisions. In partial staphyloma, treatment aims to prevent further progress, to reduce protrusion already existing, and to improve vision. Repeated paracentesis, with methodical use of pressure bandage, or iridectomy followed by pressure, may succeed. In very extensive or total staphyloma, splitting or excision may be performed —lens being also removed. *Splitting* is done

by passing knife through long diameter of tumor and allowing edges to fall together and unite, with view to producing flatter cicatrix. *Excision* performed by cutting tumor off at its base and allowing edges of wound to collapse and cicatrize. Critchett's operation [*Critchett, London*, 19*th Cent.*] consists in passing several curved needles armed with silk through base of tumor and cutting latter off just in front of them. Needles are then drawn through and sutures tied so as to unite edges of wound and form flat stump for artificial eye. Operation dangerous from risk of sympathetic ophthalmia. Often preferable to enucleate the eye, and this is always indicated where there is so much ciliary irritation as to endanger fellow-eye.

CONICAL CORNEA: KERATO-CONUS: is a cone-shaped staphylomatous protrusion of cornea whose cause is not well understood. Cornea is thinned and less resistant, but intra-ocular pressure is generally not increased and is sometimes below normal. Affection comes on as a rule very slowly, and without pain or irritation: may remain slight or advance to high degree, in which apex becomes extremely thin and is apt to be clouded—but it never bursts, except from violence. First thing noticed by patient is impairment of vision, as eye becomes myopic from lengthening of axis, and astigmatic from irregular curvature of cornea. In high grades, astigmatism causes

great distortion of images and reduplication of them. Slight grades often overlooked; high degrees may be easily seen, especially in profile. If eye is illuminated by ophthalmoscope, a central red reflex is seen surrounded by a dark ring, outside of which is a second bright red ring. By throwing light from different angles, side of cone opposite light is seen in shadow. If fundus is examined, everything appears distorted. *Treatment* unsatisfactory. Little improvement of vision from glasses. Stenopæic slit occasionally of use. All straining of eyes must be avoided. Operative treatment comprises iridectomy, iridodesis, trephining, and Graefe's operation, which consists in removing ·superficial flap from apex of cone and cauterizing part a few times with nitrate silver, so as to produce a shrinking cicatrix, and so flatten protrusion.

KERATO-GLOBUS: HYDROPHTHALMIA: BUPHTHALMOS [Gr. *βους*, *an ox*, and *οφθαλμος*, *eye*]: Is uniform spherical bulging of entire cornea and neighboring part of sclerotic, generally associated with increased size of anterior chamber and tremulous iris and lens. Condition generally congenital; may appear after inflammation. Cornea may remain transparent or become cloudy, especially at margin. Causes great impairment of vision, changes in deeper tissues and often ultimate blindness. Treatment of little use. Iridectomy seems to do most good.

FISTULA OF CORNEA: may result from wound or small perforating ulcer, and is very difficult of cure. Aqueous continually drains away and eye is kept irritated. Treatment comprises atropine; touching fistula with nitrate silver, bruising its edges with fine forceps to excite healing; compress-bandage; iridectomy.

SCLEROTIC.

EPISCLERITIS appears as a dusky red swelling on sclerotic near edge of cornea and generally on temporal side. Conjunctiva over swelling congested and chemotic. Pain and ciliary irritation may be present. Disease obstinate and not much influenced by local treatment. Sometimes yields to anti-syphilitic or anti-rheumatic remedies.

STAPHYLOMA of sclerotic generally results from inflammations which weaken tissue so that it yields before intra-ocular pressure. May be *anterior*, between cornea and equator, or *posterior*, around optic nerve. Ant. staphyloma has dirty bluish color from choroid shining through it, and is of variable size, sometimes involving whole front of eyeball. Where tumor is small, iridectomy, paracentesis, and pressure may be tried to check further progress. May be cut off in same manner as corneal staphyloma. If very extensive, may

be necessary to remove eye. Post. staphyloma generally occurs in myopic eyes (p. 150).

WOUNDS of sclerotic dangerous, according as they implicate neighboring tissues and allow contents of eye to escape. Small wounds may heal readily. Cleanly cut wounds may be united by fine suture, any protruding choroid or vitreous being cut off by scissors.

IRIS.

SIMPLE WOUNDS may heal readily or set up iritis. A severe blow upon eye sometimes causes iris to rupture at its circumference,—*coredialysis* [Gr. κορη, *pupil*, and διαλυσις, *rupture*], forming a secondary pupil, which usually remains permanent.

FOREIGN BODIES: Best way of removing one is by excising portion of iris in which it lies.

PROLAPSE OF IRIS is frequent result of perforating wounds of cornea (p. 92). If prolapsed tissue cannot be replaced it may be cut off, or treated by repeated puncture with needle, followed by compress bandage, in hope of keeping tumor collapsed and allowing edges of wound to heal over it. Atropine should be frequently applied.

IRITIS; INFLAMMATION OF THE IRIS: Chief causes are injuries, exposure, syphilis, rheumatism, and extension of inflammation from other parts. Conjunctiva is suffused, and

rosy zone of fine subconjunctival vessels appears around cornea, radiating in parallel lines from its margin. Iris appears dull, blurred, and discolored (light iris becoming greenish, and dark one brownish-red), and its movements are sluggish. This is caused by hyperæmia and plastic effusion. Discoloration partly caused also by turbidity of aqueous humor from admixture with lymph or pus. Pupil contracted and its edges may become glued by exudation to ant. capsule of lens. Such adhesions are called *posterior synechiæ* [Gr. συν, *together*, and εχω, *to hold*]. They may not be detected until atropine is applied, when pupil dilates irregularly and shows adhesions at one or more points. When whole circumference of pupil is thus adherent condition is called *exclusion of the pupil.* When exudation encroaches upon *area* of pupil, condition is called *occlusion of the pupil.* In syphilitic iritis yellowish-red nodules, analogous to gummy tumors, may appear upon surface of iris. Sometimes exudation is chiefly serous; intra-ocular tension is increased; there is less tendency to synechiæ; pupil is dilated, and there is often a deposit of lymph-particles on post. surface of cornea. Condition is then called *serous iritis*, *Descemetitis*, or *aquo-capsulitis*. Pain in iritis variable; may be very severe, and extend over forehead, temple, and side of nose (*ciliary neuralgia*), or may be entirely absent. Pho-

tophobia and lachrymation not usually severe. Vision always impaired. From close connection between iris, choroid, and ciliary body, inflammation readily extends from former to latter and *vice versa*. If, during iritis, ciliary body becomes involved (*irido-cyclitis*) there is great tenderness over ciliary region—a symptom not present in simple iritis. If choroid becomes involved (*irido-choroiditis*) symptoms are all more serious; vitreous is clouded, and there is loss of vision and contraction of field not explained by iritis alone. This condition is most common in eyes which have suffered several attacks of iritis, leaving behind extensive synechiæ. Where cornea and iris are both inflamed, disease is called *kerato-iritis*. If synechiæ are left after iritis, iris is impeded in movements and constantly dragged upon by adhesions; free communication between ant. and post. chambers is interrupted, and natural balance of pressure destroyed. This condition tends to keep up chronic irritation and to cause frequent relapses, which may finally destroy eye.

Treatment.—Perfect rest of eye and protection from light. Chief remedy is atropine. This keeps pupil dilated and away from lens so that adhesions cannot form; puts inflamed tissue at rest by paralyzing its muscles; contracts blood-vessels and lessens tension. Its action is resisted in inflammation and a strong solution should be used (2 to 6 grs. to ounce).

This may be applied at intervals of a few minutes until full dilatation of pupil is obtained, which should then be kept up by using remedy several times a day—even for some time after inflammation has subsided. Even where adhesions have already formed, atropine may cause them to be stretched and broken, if they are not too firm. When there is increased tension and great irritation, atropine may produce no effect until a paracentesis of cornea has been performed, and this is always indicated in such a condition, and may be repeated several times if beneficial. Sometimes atropine acts better after the patient has been brought under the influence of mercury. If atropine produces poisonous effects (p. 63) it must be stopped at once. Leeches and hot fomentations sometimes useful where attack is very acute. Essential to give anodynes enough to quiet pain: In syphilitic iritis, and in other forms where there is great tendency to plastic effusion, patient may be brought promptly under mercury—preferably by inunction : and iodide of potash may be given at same time. Many such cases, however, will recover without constitutional treatment, if the atropine acts efficiently. In severe and obstinate cases, with numerous synechiæ and increased tension, an iridectomy may be beneficial. Iridectomy also advisable in irido-choroiditis.

MYDRIASIS [Gr. μυδος, *moisture*; because in-

crease of fluids causes pupil to dilate ?]: DILATATION OF THE PUPIL.--Chief causes are increased tension, paralysis of third nerve, irritation of sympathetic, disease of optic nerve and brain, action of certain drugs, such as hyoscyamus, belladonna and stramonium. Mydriasis generally confined to one eye, and may be uniform or partial. When not caused by drugs, pupil not dilated to maximum and has sluggish action.

MYOSIS [Gr. μυω, *to close.*]: CONTRACTION OF THE PUPIL.—Caused by irritation of branch of third nerve supplying sphincter of pupil, by paralysis of sympathetic filaments to dilatator of pupil (such as occurs in spinal lesions), by constant work at minute objects (as in watchmaking,) by certain drugs, such as calabar bean, opium, etc. *Treatment* of mydriasis and myosis depends on cause.

HIPPUS [Gr. ιππος, *horse?*]: is chronic spasm of iris causing rapid, alternating contraction and dilatation of pupil, independent of stimulus of light. Generally associated with nystagmus.

IRIDODONESIS or TREMULOUS IRIS [Gr. ιρις, and δονεω, *to tremble.*]:—is marked by trembling of iris when eye is moved about. Caused by loss of support of crystalline lens from whatever cause.

CYSTS OF IRIS—rare, and generally result of some injury. Appear as transparent vesicles on surface of iris, attached by broad base

or pedicle. Best treatment is to excise portion of iris to which cyst is attached.

CONGENITAL DEFECTS comprise *Irideræmia* [Gr. ιρις and ερημος, *wanting*] or absence of iris: *coloboma* [Gr. κολοβωμα, *mutilation*] or cleft iris: *corectopia* [Gr. κορη, *pupil* and εκτοπος, *out of place*], or eccentric position of pupil: and *polycoria* [Gr. πολυς, *many*, and κορη, *pupil*], or multiple pupil.

CHOROID.

RUPTURE OF THE CHOROID may result from blows upon eye, with or without laceration of other tunics. Accident generally followed by hemorrhage and inflammation, with corresponding impairment of vision. Blood may be confined to choroidal stroma itself, or penetrate between it and sclerotic or retina, or into vitreous humor. Choroidal hemorrhages seen with ophthalmoscope appear as uniform red patches, lacking striation and feathery edges of extravasations into fibre-layer of retina. Sometimes retinal vessels may be seen running over them. Rupture, if seen at all, appears as pale, irregular streak, with dark edges, from pigment and extravasated blood. In some cases, blood is absorbed, wound heals and good recovery results. *Treatment* consists in keeping eye quiet and promoting absorption of blood by

such means as cold dressings, compress bandage, and leeches to temple.

Choroiditis: Inflammation of Choroid:–Rarely independent, but usually associated with inflammation of iris, ciliary body or retina.

Disseminated or exudative Choroiditis:—marked by circumscribed, yellowish spots of exudation on surface and in stroma of choroid. Retinal vessels may be seen running uninterruptedly over them, and intervening tissue appear healthy. Exudations often appear first at periphery of fundus, and advance towards centre. May increase in size and coalesce, forming larger patches. Vitreous often contains opacities, and retina may suffer atrophy from pressure of exudation. When exudations are absorbed, corresponding portions of choroid become atrophied, allowing sclerotic to shine through and forming glistening white spots. Borders of these spots are black from collections of pigment, and blood-vessels are often seen running across them. Vision is impaired, and field contracted and interrupted by scotomata. Disease often due to syphilis. *Treatment:* Rest of eyes, and protection from light by blue glasses. In both syphilitic and simple forms mercury and iodide of potash are beneficial, combined with tonics, if necessary. Eyes may be leeched occasionally, if patient is not anæmic.

Suppurative Choroiditis. Panophthalmitis.

Inflammation of all the tissues of the eye: Usually results from injuries—especially from foreign body; from operations; suppurative inflammation of cornea and iris; metastasis during typhus, cerebro-spinal meningitis, pneumonia, puerperal fever, pyæmia, etc. Is a most acute and violent suppurative inflammation involving whole eye. Lids and conjunctiva swollen, red and œdematous; cornea cloudy; aqueous turbid; iris pushed forward; pupil dilated or blocked with lymph; vitreous, retina and uveal tract infiltrated with pus; tension increased and globe very painful and tender. Disease as a rule ends in total destruction of eye and atrophy of globe. *Treatment:* Ice compresses and leeches in early stages; strong sol. atropine; division of outer canthus to relieve pressure of lids; repeated paracentesis to relieve tension and give exit to pus.

A *serous* form of choroiditis sometimes occurs in connection with serous iritis. Symptoms of inflammation may be very slight, but vitreous and aqueous are cloudy, obscuring fundus and impairing vision. Tension varies, but may increase to such an extent that glaucomatous symptoms appear. When media clear up, no changes may be apparent except posterior polar cataract. *Treatment:* rest; blue glasses; atropine; leeches; paracentesis or iridectomy if tension is much increased.

Sclerotico-choroiditis posterior; sclerectasia

posterior; posterior staphyloma :—Is prolongation of posterior half of eye with stretching, inflammation and atrophy of choroid. Precise etiology disputed. Occurs commonly in highly myopic eyes, leading to still further increase of myopia. Occurs rarely in hypermetropia. Predisposition seems to be congenital, and exciting causes to be strong efforts of accommodation and convergence for near vision, and continued hyperæmia of posterior scleral zone. May be stationary or progressive. In former case, ophthalmoscope shows more or less regularly-shaped crescent at outer edge of optic disc (or a zone extending nearly or quite around disc) of glistening white color, from sclerotic shining through the atrophied choroid, and with edges well defined, and fringed with pigment ; retinal vessels are seen running over it ; myopia does not increase, and eye is not painful or irritable. But if affection is progressive, inflammatory symptoms are added : edges of crescent are congested and blurred ; additional white patches appear about it and unite with original one ; vitreous becomes turbid ; myopia increases ; eye is irritable and vision impaired. Glaucoma, detachment of retina, or choroidal hemorrhages may supervene. Sometimes crescentic atrophy of choroid occurs without any staphyloma of sclerotic. *Treatment :* In active form, complete rest of eyes ; blue glasses ; avoidance of all causes of congestion ;

cold douche; leeches; atropine. (*Vide* Myopia.)

TUMORS OF CHOROID: chiefly varieties of sarcoma. First appear as small nodule, which increases until it fills globe, bursts through cornea, and appears externally as ulcerated, bleeding surface. In their progress they cause increased tension, and may thus be mistaken for glaucoma. They tend to recur and to invade neighboring tissues. *Treatment:* excision of eye as soon as tumor is detected. If orbital tissue is affected, as much as possible should be removed, and remaining surface cauterized.

TUBERCLES IN CHOROID: Occasionally found in acute tuberculosis. Appear as minute, circumscribed, rose-colored or whitish spots, and produce little or no loss of vision.

DEPOSITS OF BONE IN CHOROID: Sometimes found in eyes which have been long atrophied.

COLOBOMA OF CHOROID generally coexists with coloboma of iris and ciliary body. There is usually bulging outward of corresponding part of sclerotic. With ophthalmoscope it appears as white cleft in fundus, with well-defined brownish edges, running from ciliary region toward disc. Retinal vessels may run straight across the white line, or be seen dipping into bulge of sclerotic.

CILIARY BODY.

CYCLITIS. [Gr. κυκλος, *circle.*] INFLAMMATION OF CILIARY BODY: Generally arises in connection with iritis and choroiditis, but may also come from injury. Diagnostic symptom is pain over ciliary region, especially when this is pressed upon. Also, zone of ciliary injection around cornea; photophobia and lachrymation; enlargement of veins of iris; increase of tension; turbidity of aqueous and vitreous; loss of accommodation and impairment of vision. Exudation may be serous, plastic or purulent. *Traumatic cyclitis*, caused by wounds in ciliary region, foreign body in eye, dislocated lens, &c. May result in fatal suppuration and atrophy of globe in spite of every precaution, and may also cause sympathetic inflammation of other eye. Leeches, hot or cold applications, and atropine, may be tried, but if disease progresses unfavorably removal of eye is advisable, to ensure safety of other one. Cyclitis occurring in course of iritis or choroiditis requires same treatment as those affections, and may recover perfectly.

RETINA.

HYPERÆMIA is caused by prolonged exposure to bright light; by fine work, espe-

cially where there is refractive defect; and by inflammation. Fundus looks too red ; papilla pinkish, and its outlines indistinct ; arteries may be a little enlarged, and smaller branches more numerous than usual, and veins generally pulsate. Eye is irritable, easily fatigued, and dreads light. Indications are to remove cause, put eye at rest, and protect it by blue glasses. Leeches and cold douche may be useful.

Passive venous congestion occurs from any obstruction to outflow of venous blood. Veins appear large, dark, tortuous, and pulsating.

HYPERÆSTHESIA OF THE RETINA :— When not dependent on inflammation, is most commonly caused by straining of eyes in fine work, by exposure to very intense light, etc. The patient is unable to use his eyes, owing to dazzling sensations, phosphènes, morbid persistence of retinal impressions, lachrymation, spasm of orbicularis, and ciliary neuralgia. Very rarely, with these symptoms there is *nyctalopia* [Gr. νυξ, *night*, and οψις, *vision*], or the power of reading, etc., by very faint light. Otherwise, the eyes may appear perfectly normal. The treatment consists in rest of eyes, blue glasses, tonics, allaying of all nervous excitement, etc. If there is a refractive defect, it should, of course, be corrected.

ANÆSTHESIA OF THE RETINA :—Is a blunting of the retinal sensibility without any

perceptible organic change. Most common causes are prolonged exposure to intense light, lightning-stroke, concussion of eye or head, disuse of eye (as in squint), neuralgia of fifth nerve, and old age. Distinctness of vision is impaired, especially in feeble light—*hemeralopia* [Gr. ἡμερα, *day*, and οψις, *vision*]. Treatment must depend on cause. Perfect cure often results. In anæsthesia from disuse, systematic exercise in reading with affected eye is often beneficial.

RETINITIS; INFLAMMATION OF RETINA: Caused by severe exposure to bright light or fine work; syphilis; Bright's disease; extension of inflammation from other tissues; embolism of central artery; injury, etc. Usually associated with inflammation of optic nerve (*neuro-retinitis*). May also be combined with inflammation of choroid and vitreous. Generally affects connective tissue primarily, and extends later, if at all, to nerve elements. Inflammatory product infiltrates tissue, and appears as exudation upon surface, being evenly spread over it or collected into irregular patches. Retina swollen and œdematous. Tissue and vessels may undergo sclerosis, fatty degeneration and atrophy. Extravasations of blood often occur; most common in inner layers, but may extend to choroid or into vitreous; may be absorbed or changed into opaque, degenerated mass. When very extensive, condition is called *retinitis apoplectica*. [Retinal

apoplexy may also occur without inflammation, from injury or atheroma of vessels]. In retinitis of Bright's disease (*retinitis albuminurica* or *nephritica*) there is large amount of exudation, which soon becomes fatty, in region of papilla, and also numbers of white, glistening, stelliform spots scattered about; and hemorrhages are numerous. In retinitis, in course of syphilis, there may be numerous white, punctiform opacities, especially in region of macula, and hemorrhages are not likely to occur. In retinitis of leucocythæmia (*retinitis leucæmica*) there are round, yellowish-white patches, sometimes with red borders, strewn about periphery of retina, and near macula—formed from masses of exuded white and red blood-corpuscles; fundus has pale yellow tint, and arteries look pale and bloodless. Suppuration of retina scarcely ever occurs except in panophthalmitis.

Ophthalmoscopic appearances of retinitis are: Opacity of retina, varying in degree from that of fine mist or film to that of dense, white patch of exudation. Vessels are obscured the more the opacity lies in inner layers. Disc looks blurred, especially its edges. Arteries usually of normal calibre, but veins distended and tortuous. Blood-extravasations appear as irregular, red patches; if in inner layers, among nerve-fibres, they are striated, and have feathery edges; if in outer layers, they appear more smooth and uniform. Ex-

ternally appearances of eye usually normal. Vision impaired according to severity of inflammation, and extent to which nerve-elements suffer. Sometimes it remains normal, when ophthalmoscopic appearances are very marked. A very common complaint is that everything is seen through a mist or haze. Pain generally slight. Disease may run acute or chronic course, and end in recovery or in incurable atrophy and blindness.

Treatment: Complete rest of eyes. Blue glasses. Special attention to general health. Leeches to temple in acute stages. Small doses of mercury sometimes act well.

Retinitis pigmentosa; Pigmentary degeneration of retina:—Generally hereditary and associated with other bodily defects. Begins in early childhood, and runs very slow course, usually affecting both eyes. Often combined with *post. polar cataract.* Characteristic ophthalmoscopic appearance is a peculiar deposit of pigment scattered over retina, appearing as irregular, stellate, black spots, with branching processes (something like bone-corpuscles in form), and as small black lines, showing tendency to follow course of vessels. Retina and disc atrophied and vessels small. Choroid also atrophied in some cases. There is gradual contraction of visual field and increasing torpidity of retina. About the first symptoms noticed is hemeralopia (p. 113). No treatment of any service.

Detachment of Retina: caused by effusion of inflammatory material, blood, &c., between choroid and retina; by loss of its support from diminution in bulk of vitreous; by elongation of eye, as in myopia; by tumors beneath it; or may occur without any apparent cause. May be partial or complete. With ophthalmoscope an ordinary partial detachment appears as a tremulous, bluish-gray sac projecting into vitreous, with retinal vessels bending over it, and surrounded by red choroidal reflex. Very small detachments may appear as fine gray streaks. In total detachment no reflex can be obtained from fundus at all. Symptoms complained of are floating cloud before eye, metamorphopsia, and loss of vision in part of field corresponding to detachment. Thus if lower half of retina is detached, upper half of field will be absent, &c. Prognosis unfavorable. Tendency of detachment is to increase. Only exceptionally it ruptures, or subjacent fluid is absorbed and retina falls back into place and some degree of sight is restored. *Treatment* chiefly expectant. Success has been reported from keeping patient for long time on his back, and also from operation of passing needle in through sclera and opening sac so as to allow fluid to escape and retina to fall back into place.

Embolism of Central Artery of Retina: Causes sudden blindness without pain

or irritation. Optic disc appears blanched, and retinal vessels reduced in size and more or less bloodless. Arteries may appear as small white threads; veins small and irregularly filled. Soon retina becomes opaque, except at fovea, which appears as cherry-red spot from choroidal reflex. Condition ends in atrophy of nerve and retina, and is irremediable.

Epilepsy of the Retina:—Is characterized by sudden dimness of vision, advancing from the periphery of the field toward the centre, until total blindness results, which lasts generally but a few minutes, and then completely disappears. The attacks occur at variable intervals, and affect one or both eyes. Condition is supposed to be due to spasm of retinal vessels. Affection is rare.

Tumors of Retina: *Glioma* [Gr. γλια, *glue*]: is composed of round, spindle-shaped, and branching cells, with granular, intercellular substance, and originates in retinal connective tissue. Occurs almost exclusively in young children, and often unnoticed until far advanced. Appears as bright, yellowish tumor, projecting into vitreous. Surface vascular, and retina in vicinity detached. Eye may look normal externally and be painless, but vision is lost. As tumor grows, it fills globe, presses forward iris and lens, bursts through cornea, and presents externally fungous, bleeding surface—occasioning great

suffering. Excision of eye is only remedy. Disease may recur in orbit or extend back to brain.

CRYSTALLINE LENS.

CATARACT: Is an opacity of crystalline lens caused by interference with its nutrition. May thus result from senile involution; debilitating disease, such as diabetes; inflammation, especially of uveal tract, which cuts off blood-supply or extends to lens itself—*phakitis* (Gr. φακος, *lens*); or from injury. *Ergotism* has been observed as cause, but precise mode of action not understood. In majority of cases cataract occurs after 45. But may occur at any age, and is sometimes congenital. Many forms described, but great practical division is into (1.) *Soft* or *cortical cataracts*, occurring below middle age, and of soft consistence throughout. (2.) *Hard* or *nuclear cataracts*, occurring after middle age, and containing a dense nucleus. Opacity generally begins at margin of lens and advances as fine stripes or dots towards centre, until at last whole lens is opaque, and cataract is said to be *mature* or *ripe*. Soft cataract usually progresses rapidly, especially in children. After reaching maturity it may undergo secondary changes; more fluid parts may be absorbed, and remainder become small, shrivelled disk

of fatty or chalky consistence; or fluid parts may increase so that capsule is filled with milky liquid. A cataract with fluid cortex and hard nucleus is sometimes called a *Morgagnian cataract*. *Traumatic cataract* is soft cataract following injury and devéloping usually with special rapidity. Most frequent causes are wounds which perforate capsule and allow aqueous humor to reach lens-substance, which becomes soft and opaque, and may swell to such an extent as to press upon neighboring parts and excite dangerous inflammation. In more favorable cases it may be wholly or partially absorbed. Traumatic cataract may also result from simple concussion, without any rupture of capsule. Partial cortical cataracts may occur and are often called *capsular cataracts*. They are usually not due to changes in capsule, but to changes in cortex near its inner surface. After iritis or perforating ulcer of cornea a deposit of lymph is often left on ant. capsule of lens (p. 92); superficial lens-matter just beneath may also suffer in its nutrition and become opaque, while intervening capsule remains transparent. This is called *ant. central capsular cataract*. If it projects much above capsule it is called *pyramidal cataract*. An opacity of cortical substance lying upon post. capsule, or a deposit of lymph upon latter from vitreous, is called *post. polar cataract*, and is much less frequent. Sometimes a single layer of lens-

fibres becomes opaque, while remainder retain their transparency. This form is called *laminated*, *lamellar*, or *zonular cataract*, and is most common during infancy and youth. It may remain stationary or become complete. *Nuclear*, *hard*, or *senile cataract* is distinguished by a hard, central portion or *nucleus*, surrounded by a less dense layer of cortical substance. As cataract progresses, distinction between cortex and nucleus becomes more and more evident, latter appearing as round, central patch of greater or less size and of yellowish color. Progress usually slow, years often elapsing before cataract matures. Retrogressive changes may occur, as in soft form. Soft cortex may undergo absorption or fatty and chalky degeneration, while nucleus becomes harder. Capsule is then apt to become tough and adherent. The name *black cataract* has been applied to a very rare form, where the color of the lens is very dark.

Symptoms: A fully formed cataract is easily seen, as pupil is filled by grayish opacity. Incipient or partial cataracts may be seen by oblique illumination or ophthalmoscope. If latter is used, mirror only is employed, when, on illuminating eye, any cataractous opacities appear as black spots against red background. To ensure thoroughness, pupil should be dilated by atropine. Complete soft cataracts, when seen by oblique illumination, present bluish-gray opacity

slightly denser at centre than at margin. In hard cataracts opacity presents yellow nucleus surrounded by grayish cortex. In pure lamellar cataract, opacity is uniform and sharply marked off from transparent border and overlying strata of lens. With ophthalmoscope, opacity appears as dark disc, and light shines through it from fundus. Vision impaired just according to degree of opacity. When cataract is congenital, or has developed in childhood, the lack of vision may cause loss of functional power of retina, or muscular derangements, such as strabismus and nystagmus (p.134). In cataracts appearing after puberty these effects seldom seen.

Treatment: Medicine accomplishes nothing except in way of improving general health, and so impeding progress of opacity. While cataract is maturing, vision may be temporarily improved by dilating pupil, by shading eye from light or by atropine. In partial cataracts which have become stationary, operation for artificial pupil may be performed to expose clear portion of lens. Complete cataract may be removed by one of several operations (p. 67). If degenerative changes have occurred, removal of lens is more difficult. Before operation, vision and field should be tested ; for, if function of retina has been lost, operation is useless and unjustifiable. Progress of cataract may be hastened by opening capsule with needle, so

that aqueous humor may act upon lens. In traumatic cataract from rupture of capsule, eye should be treated with atropine and bandage, just as if a needle operation had been performed. If lens-matter swells excessively, it should be evacuated at once through corneal incision. Chief bad results from extraction of cataract are suppuration of cornea, iritis, irido choroiditis, prolapse of iris, and imperfect union of corneal wound. After lens has been removed, cornea is only refracting surface left, and strong convex glasses are needed to give acute vision, except in rare cases where eye was very highly myopic before operation. As accommodation is lost, spectacles give acute vision only at one distance, and more than one pair is thus needed. Where lens has been removed from only one eye, and other is normal, spectacles cannot be used, because of very different refraction of eyes. Still, eyes adapt themselves to new conditions, and work fairly together.

Secondary Cataract: Is name applied to opacities which appear in area of pupil after lens has been removed. [Also applied to cataract following another disease of eye.] Opacities may be in capsule or due to lymph-deposit from iritis; or to particles of lens matter left behind by operation. Capsule may cause impairment of vision by becoming wrinkled, without being opaque. Operations for such secondary cataract consist in tearing

a hole through them by needles passed in through cornea. If there is much lymph in pupil, iridectomy may be necessary.

DISLOCATION OF LENS; ECTOPIA LENTIS [Gr. ἐκ, *from*, and τοπος, *place*]: Generally results from injury, but may be spontaneous from weakening of suspensory ligament. May be complete or partial. In latter form, lens may be moved to one side, so that its margin crosses area of pupil, or it may be merely rotated on its axis. Iris tremulous, where support of lens is lost. Vision greatly disturbed. Artificial pupil may be made in more favorable place, or lens may be extracted, especially if it causes irritation. In total dislocation: (1) lens may lie in ant. chamber. (2) In vitreous. Is then apt to act as foreign body, and may cause sympathetic trouble. (3) Under conjunctiva. This only occurs where heavy blow has ruptured sclerotic, leaving conjunctiva intact. In all cases of total dislocation, lens should be removed as soon as possible.

LENTICONUS or CONICAL LENS has been observed.

VITREOUS HUMOR.

FOREIGN BODIES lodged in vitreous usually excite dangerous inflammation and may cause

sympathetic disease. Very rarely they become encapsulated and remain harmless for a long time. Removal should be attempted, but is difficult.

HEMORRHAGE INTO VITREOUS is caused by rupture of vessels from injury or disease. Blood generally comes from choroid, and retina is detached and ruptured. Sudden obscuration of sight results. Small hemorrhages may be seen with ophthalmoscope as dark, reddish masses, against red background. A very extensive one renders vitreous so opaque that no reflex can be obtained from fundus. Blood may be slowly absorbed leaving only a few dark floating opacities and good vision be restored; or eye may be destroyed.

OPACITIES OF VITREOUS, result from inflammation or hemorrhage, and cause annoying disturbance of vision, appearing as black spots floating before eye. Are of various shapes—dark dots, threads, membranes, etc. If eye is illuminated from a distance of 12″ by ophthalmoscope and then moved quickly in various directions, opacities are easily seen floating about behind lens. Sometimes opacity is diffuse, making fundus appear hazy and indistinct. *Treatment* must be directed to primary disease.

Muscæ volitantes [Lat. *musca*, *a fly*, and *volito*, *to fly about*], are floating opacities often complained of, but purely subjective, and occurring in perfectly normal eyes. They appear

usually as bright beads floating through field when patient regards a bright clear surface—such as a white wall, sheet of paper, etc. They are due to the vitreous cells, and cannot be seen by ophthalmoscope—which distinguishes them from pathological opacities. Only treatment is to quiet patient's fears concerning them.

HYALITIS: INFLAMMATION OF HYALOID OR VITREOUS BODY;—is, usually, secondary to inflammation of surrounding tissues. The changes are cell-proliferation, fatty degeneration, connective-tissue formation or suppuration, and become evident by opacity they cause. Inflammation may be partial or complete. New formation may be reabsorbed or remain permanently. Vitreous may degenerate and become fluid. This state is called *synchisis* [Gr. συν, *together*, and χυσις, *flowing*,] and may be diagnosticated, if there are opacities, by the rapidity and freedom of their movements. If cholesterine is present it appears as sparkling crystals, and condition is called *synchisis scintillans* [Lat. *scintilla*, *a spark*]. Fluid vitreous is generally followed by shrinking and atrophy with falling forward of retina, &c. A soft vitreous does not cause a soft globe, if tension is increased. *Treatment* of hyalitis is that required for primary affection.

CYSTICERCI have been found in vitreous, generally projecting from the deeper tissues.

PERSISTENT HYALOID ARTERY has been observed as a dark, withered thread running part or all of the way between optic disc and post. pole of lens.

ANTERIOR CHAMBER.

HYPOPION [Gr. ὑπο, *under*, and πυος, *pus*.]; is a collection of pus or lymph at bottom of ant. chamber. Effusion may come from cornea, iris or ciliary body. May be reabsorbed, or, if not too tenacious, may be evacuated through incision made at lower edge of cornea.

HYPÆMIA [Gr. ὑπο, *under*, and αἱμα, *blood*,] is an effusion of blood into ant. chamber, and may result from wound of anterior part of eye, or from simple blow without rupture of coats; or, *very rarely*, it may be spontaneous. Best remedy is compress bandage to hasten absorption.

FOREIGN BODIES sometimes lodge in ant. chamber. They should always be removed if possible, through incision in cornea.

OPTIC NERVE.

OPTIC NEURITIS; INFLAMMATION OF THE OPTIC NERVE:—Usually caused by extension of inflammation from another part or

from pressure upon nerve and obstruction to its circulation. Occurs in connection with abscess, periostitis and tumors of orbit, basilar meningitis, tumors of brain, collection of fluid between sheaths of nerve, etc. Is called *ascending* or *descending*, according as it originates in eye and extends upward along nerve, or *vice versa*. Ophthalmoscopic appearances are due to hyperæmia, exudation and swelling. In marked case, disc looks red, opaque and prominent, with margins very indistinct, giving it a *woolly* appearance. Vessels are seen dipping into swollen mass and partly obscured by it. Veins distended, tortuous and pulsating. This condition is called *engorged papilla*, *Stauungs papilla*, [Ger. *Stauen*, *to dam*], or *choked disc*. Vision impaired—but often less so than appearance of disc would indicate. Process usually ends in atrophy of nerve and permanent loss of sight. Neuritis generally associated with retinitis as *neuro-retinitis*. *Treatment* varies with cause, and this is sometimes beyond reach of any remedies. Rest, and blue glasses are always proper. Leeches, mercury, iodide and bromide of potash are of service in some cases.

ATROPHY OF OPTIC NERVE results from inflammation, and from other disturbances of innervation and nutrition, some of which are but little understood. Seen with diseases of brain and spinal cord; diseases of orbit;

pressure on nerve; blood-poisoning; anæmia, etc. Disk looks flat, opaque, and of glistening white (*white atrophy*), or bluish-gray color (*gray atrophy*), with its capillaries obliterated, and presents a shallow excavation with sloping edges, over which vessels run without any abrupt curve. Retinal vessels small—arteries often appearing as fine threads. In some cases, however, veins remain large and tortuous, as in inflammation. Vision impaired; field contracted and interrupted by scotomata; and usually color-blindness. In exceptional cases, disc presents appearance of advanced atrophy and vision remains perfect or nearly so. *Treatment* adapted to cause and to general condition of patient. Marked benefit sometimes obtained from subcutaneous injections of strychnia beginning with gr. $\frac{1}{60}$, and gradually increasing dose until poisonous effect appears.

Tumors of Optic Nerve have been observed, but are very rare.

Opaque Optic Nerve Fibres: Appear when medullary sheaths are retained for a certain distance, instead of being lost at lamina cribrosa as they normally are. Most common form under which they appear is as an irregular, white, striated opacity with feathery edges, projecting from margin of disc for a short distance into retina. Retinal vessels may or may not be hidden by it. Disc and all

other parts of fundus look natural, and vision is not impaired except by a slight enlargement of normal blind-spot. These facts serve to distinguish opaque fibres near disc from an exudation in that region.

AMAUROSIS.

AMAUROSIS [Gr. αμαυροω, *to render obscure*,] and AMBLYOPIA [Gr. αμβλυς, *dull*, and ωψ, *eye*]:—are names which were formerly much used to denote the various conditions of blindness, before the diagnosis of ocular disease was as exact as it now is. As they convey no definite idea of the nature of the disease, they are objectionable wherever a more exact term can be used. The term *amblyopia* is still found convenient to designate certain conditions of impaired vision where no organic changes can be seen to account for them. Vision is often thus defective where eye has been long disused, as in strabismus—*amblyopia from disuse*, or *ex anopsia* [Gr. ανα, *without*, and οψις, *vision*] : in anæmia from severe illness or hemorrhage—*anæmic amblyopia* ; in alcoholism—*amblyopia potatorum* [Lat. *potator*, *drinker*] ; in uræmia ; lead-poisoning ; from excessive use of tobacco ; from exposure to prolonged glare, as in snow-blindness, and hemeralopia ; from irritations of fifth nerve,

as in neuralgia, etc. *Treatment* consists primarily in removing any supposed local or general cause. Hypodermic injections of strychnia (p. 128) often of service. In some cases vision is restored; in others it deteriorates, and atrophy of nerves becomes apparent.

GLAUCOMA.

GLAUCOMA [Gr. *Γλαυκος*, *green*: from greenish reflex sometimes seen in disease.] ARTHRITIC OPHTHALMIA.—A very dangerous disease of eye occurring usually after middle age, and which, if unchecked, ends in incurable blindness. Essential feature is increase of intra-ocular fluids, causing distention of tunics and destructive pressure upon them. Exact etiology of process not perfectly determined: supposed by some to be due to perversion of nerve influence governing secretion. Rigidity of sclerotic, interfering with perfect balance of blood-supply seems to play important part. Large percentage of cases occur in hypermetropic eyes. Disease generally attacks one eye first and other subsequently. Generally, premonitory stage of varying duration, and more or less marked by following symptoms: rapid increase of presbyopia, intermittent obscurations of sight; appearance of colored rings around a light; contraction

of visual field ; slight increase of tension ; ciliary neuralgia.

Acute inflammatory glaucoma presents all symptoms of severe internal inflammation. There is ciliary and conjunctival congestion ; photophobia ; lachrymation ; aching pain in globe and over head, with perhaps fever and vomiting ; cornea cloudy ; iris pressed forward and ant. chamber shallow ; pupil dilated and perhaps filled with greenish reflex ; aqueous and vitreous turbid ; tension increased, even to stony hardness. Vision much impaired. If fundus can be seen, arteries are found to pulsate spontaneously or from slight pressure on globe, veins are dilated, tortuous and pulsating ; and small hemorrhages may appear in retina. If tension has existed long enough, optic disc is found cupped in characteristic manner : excavation extends to margin of disc and its edges are abrupt, steep, and sometimes undermined ; nerve is of bluish-gray color, increasing in intensity towards periphery : retinal vessels appear distorted or interrupted where they pass over edge of cup : if object-lens (examining by indirect method) is moved sideways, a parallax is obtained, margin of excavation appearing to move over its centre "like a frame over a picture." Severity and course of disease very variable. May be very rapid, destroying sight in a few hours—*glaucoma fulminans* [Lat. *fulmen, lightning*] ; or, acute symptoms may subside,

leaving eye more or less damaged, and then recur again and again until complete blindness ensues—globe being hard as stone, cornea dull and anæsthetic, ant. chamber shallow, pupil dilated and lens opaque—*glaucoma absolutum.*

Chronic or *simple glaucoma :* leads to same results as acute, but in very insidious manner —chief symptoms being increased tension, cupping of disc, contraction of field and loss of vision. Affection may progress thus quietly for a time, and sudden acute inflammatory attack then supervene. Believed by some that use of atropine in chronic glaucoma may precipitate acute attack.

Secondary glaucoma is name applied to glaucoma ensuing upon one of the ordinary injuries or inflammations of eye.

Treatment : Great remedy for glaucoma is iridectomy—first applied by von Graefe in 1856. It acts beneficially by permanently reducing ocular tension, and if performed in early stage of disease, may be curative. As disease advances prospects of benefit from operation lessen. Trephining sclera has been proposed.

SYMPATHETIC OPHTHALMIA.

An extremely dangerous inflammation attacking sound eye after disease or injury of its fellow, and propagated through medium of ciliary nerves. Conditions most apt to cause it are injuries in ciliary region ; foreign bodies within

globe ; inflammations involving ciliary body. Seen most commonly in young. Period of occurrence variable : may appear shortly after injury or not until many years have elapsed—injured eye having perhaps meanwhile atrophied to a shrivelled stump. Danger of it cannot be considered as past so long as injured eye remains, especially if this shows any tenderness or irritation. Disease may come on very insidiously, and is often unnoticed until beyond hope of aid. There is a condition called *sympathetic irritation* quite different to sympathetic ophthalmia—regarded by many as premonitory stage of it. In this condition, eye is irritable and perhaps slightly injected ; there is photophobia, lachrymation and neuralgic pain ; power of accommodation is diminished, and eye is quickly fatigued by fine work. These symptoms may recur repeatedly and pass off leaving no organic changes, and they cease completely after other eye is removed. *Sympathetic inflammation* attacks iris, ciliary body, choroid, retina, and vitreous—extent to which these different structures are involved varying in different cases. Tendency is toward rapid plastic effusion, which glues different tissues together and destroys them. Iris is bound to lens and becomes degenerated and rotten ; it may be drawn backward by the adhesions or bulged forward by exudation behind it. Masses of lymph may fill pupil or be seen floating in

vitreous. There is ciliary congestion, photophobia, lachrymation, with rapid loss of sight. Pain may be severe or absent, but there is almost always tenderness of ciliary region. Tension increased at first, but reduced later, as eye degenerates. *Treatment* must be mainly preventive, as little can be done when disease is once established. A blind eye from which there is slightest risk of sympathetic ophthalmia is always better removed, especially if patient lives some distance from medical aid. If injured eye possesses some sight, it may be left, but should be closely watched, and enucleated the moment it sets up sympathetic irritation. If disease is established, offending eye should be at once removed, but chances of benefit are then small. Complete rest of eye and protection from light, strong sol. atropine frequently applied, tonics and good food, are all important.

MUSCLES.

STRABISMUS OR SQUINT [Gr. *στραβιζω, to squint*,] is a loss of proper balance between muscles, so that when visual line of one eye is fixed upon object, that of other deviates more or less from it. Caused by anything which develops preponderance of power in a muscle, either directly or indirectly. May thus arise from some refractive anomaly; from

anything which prevents binocular vision (cataract, corneal opacity, &c.) in which case the excluded eye yields passively to muscle which happens to be strongest ; or from paralysis of muscles. Chief forms are *convergent strabismus* (eye deviating inward), and *divergent strabismus* (eye deviating outward.) An upward squint is called strabismus sursumvergens ; a downward squint, strabismus deorsumvergens. Squint confined to one eye (*monolateral*) ; or may appear sometimes in one and sometimes in other (*alternating*). Range of motion of squinting eye may be curtailed, or it may be as great as ever—only displaced toward side of contracted muscle—as is usually the case in alternating squint. To determine which is squinting eye, direct patient to look at your finger held before him, and cover each eye alternately with your other hand. If uncovered eye remains fixed on object when other is covered, it is eye usually used for fixation. If it has to move to bring its visual line upon object, it is one which usually squints. Deviation of squinting eye when sound eye is fixed upon object is *the primary deviation*. Movement which sound eye makes when covered with hand, while squinting eye is made to fix its visual line upon object is *the secondary deviation*. When primary and secondary deviations are equal, and squinting eye accompanies healthy one in its movements, strabismus is called *con-*

comitant. Strabismus measured by distance between two points marked on lower lid to correspond with position of centre of pupil of squinting eye (1) when its visual line is fixed upon object, and (2) when visual line of healthy eye fixes object. Instruments for noting this distance called *strabismometers.* When squint is monolateral, squinting eye is frequently amblyopic, from habit which patient acquires of mentally suppressing its retinal image, so as to be rid of the diplopia. In alternating strabismus, first one eye deviates and then the other, and vision of both may remain equally good. Strabismus is at first accompanied by diplopia, but this usually disappears later (p. 51).

Convergent or *Internal Strabismus :* is due to hypermetropia in great majority of cases. In H. the accommodation is constantly called into excessive action, and this is always associated with increased convergence. In attempting to increase accommodation, so as to gain clear vision, one eye squints inward. At first, squint may be *periodic*, appearing only when close work is undertaken ; but it soon becomes permanent. Convergent squint is most frequent in *moderate degrees of H*, where sight is markedly improved by these increased efforts of ciliary and interni muscles. Very rarely it occurs in moderate degrees of myopia, where eyes are much used at fine work, and internal recti become permanently contracted

from excessive use. It may also occur from division or paralysis of external rectus (p. 139).

Divergent Strabismus ; is most frequently accompanied by myopia. In this condition, efforts at convergence are made difficult by shape of eyeball, and internal recti become strained and weakened allowing eye to deviate outwards (p. 150). Also, when one eye is blind or very defective the impulse to binocular vision is lost, the internal rectus grows weak and divergence occurs. It may also be produced by division, paralysis, or defective innervation of opposite muscle (p. 139).

Treatment for concomitant squint (which must always be carefully distinguished from the paralytic) consists in dividing tendon of shortened muscle. This weakens muscle by allowing its tendon to recede and acquire new insertion further back on sclerotic, and so, indirectly, strengthens opposite muscle. Where deviation is great, it is often necessary to operate on both eyes, to obtain full correction. After operation (p. 69), suitable glasses should be worn to correct the refraction and prevent recurrence of the squint.

PARALYSIS OF THE NERVES SUPPLYING THE MUSCLES :—One or more of the nerves may be affected, and paralysis may be total or partial (*paresis*). A fixed squint may result ; or the trouble may be difficult to de-

tect, being only manifest by diplopia and impaired mobility in a certain direction. Causes of paralysis often obscure. It may result from pressure on nerve; from cerebral or orbital disease, from syphilis, rheumatism, &c.—syphilis being most frequent cause. Mode of examining muscular movements was given at p. 53. The diplopia generally shows which muscle is affected, as a certain form of it accompanies each different paralysis. If paralytic squint is present, it is distinguished from concomitant form by fact that secondary deviation is greater than primary, instead of being just equal to it. This results from fact that deficient innervation of paralysed muscle demands a greater effort than normal to bring eye into a given position; and this being reflected upon healthy muscle of other eye causes a disproportionate secondary deviation.

Paralysis of third nerve: is the most frequent. May be complete or partial, and affect one or all of the branches. In complete paralysis, upper lid droops (ptosis) and eyeball is left to control of external rectus and sup. oblique muscles, which draw it outward and a little downward—movements caused by sup. inf. and int. recti and inf. oblique being absent. Pupil dilated and immovable, and accommodation lost. There is crossed diplopia. In partial paralysis, all above symptoms may exist in lesser degree, or only some filaments of nerve may be affected, and loss of power

be thus confined to one or two muscles. If branch to int. rectus is paralysed there is deficient mobility inward and crossed diplopia, images being on same level and parallel. If sup. rectus is paralysed, there is impaired motion upward and inward, and diplopia occurs above horizontal line, images being crossed, and diverging at top, false one standing above true. If inf. rectus is paralysed. there is impaired motion downward and inward, and diplopia appears below horizontal line. Images are crossed, false one standing below true, and they converge at top.

Paralysis of fourth nerve : paralyses sup. oblique muscle. There is impaired motion downward and outward, and homonymous diplopia below horizontal line. Images converge at top and false one stands below true.

Paralysis of sixth nerve : paralyses ext. rectus. There is impaired motion outward and homonymous diplopia, images being on same level and parallel.

Treatment of paralysis must depend on cause. Electricity sometimes of use. To relieve patient from diplopia, affected eye may be covered with shade, or a prism worn to fuse images. If all treatment fails, division of opposite muscle and re-adjustment of affected one may be performed (vide p. 69).

NYSTAGMUS [Gr. *νυσταγμος, a nodding?*] : is marked by involuntary, spasmodic oscilla-

tions of eyeball. Movements generally horizontal and in both eyes. May be periodical or continuous, and is increased by general excitement or accommodative efforts. Vision much confused, and patient often improves it by inclining head in direction opposite to that in which eyeballs oscillate. Nystagmus generally appears in infancy, in cases where clear vision is difficult (on account of corneal opacities, refractive defects, cataract, &c.) and eyes are thus subjected to undue strain. *Treatment* chiefly prophylactic, as little can be done after condition is established. Whatever improves vision tends to improve nystagmus.

MUSCULAR ASTHENOPIA; INSUFFICIENCY OF INTERNAL RECTI. Occurs generally in high degrees of myopia, which cause increased convergence and over-taxing of muscles. Also occurs in general muscular debility; and, rarely, in hypermetropia. Causes marked asthenopia when fine work is attempted. Tests for insufficiency were given at p. 53. The power of recti interni and externi should be tested for near and distant vision by finding what prisms they can overcome. (p. 51). Power of externi is called the *abduction* or *facultative divergence*; that of interni, *adduction* or *facultative convergence*. *Treatment:* General tonics and hygiene. Concave glasses which enable patient to work at 12 or 14

inches. Prisms, base inward, to relieve strain upon interni. If these means fail, division of external recti to weaken their power. Advisability of operating on one or both of the externi depends on degree of insufficiency and on power of abduction.

EYELIDS.

The eyelids are subject to same affections as other parts of general integument—such as *hyperæmia*, *œdema*, *inflammation and abscess*, *erysipelas*, *acne*, *herpes*, *eczema*, *warts*, *nævi*, *syphilitic ulcers*, *cancer*, *&c.* These require same general treatment here as elsewhere. Special danger to be guarded against is that of inflammatory and cicatricial changes which easily produce deformity of lids with all its bad results.

BLEPHARITIS MARGINALIS OR CILIARIS [Gr. *βλεφαρον*, *eyelid*]; TINEA TARSI; OPHTHALMIA TARSI :—Essentially an inflammation of hair-follicles along edge of lid, but other structures soon become involved also. Edge of lid is at first hyperæmic; and later, swollen, smooth and glossy. Discharges form small, yellow scabs, which glue lashes together in little bundles. Little pustules appear about roots of lashes, which may leave small ulcerations and fissures. Hairs fall out,

and new growth is apt to be thin, stunted and misdirected. If disease progresses, edge of lid may become hypertrophied and callous, constituting *tylosis* [Gr. τυλη, *callus*]; and it may also be everted. Hairs may cease to grow altogether, leaving lid bald—*madarosis*, [Gr. μαδαρος, *bald*]. Disease occurs in course of other inflammations; from exposure to irritating influences; in general debility, from whatever cause; and is most common among poor and dirty classes. Is often associated with some refractive anomaly, and disappears when this is corrected. Is very obstinate and recurrent. In *Treatment*, cleanliness is of first importance. Crusts should be washed away several times a day with warm water or alkaline lotion (such as 10 grs. soda to ℥i.); after cleansing, some astringent should be applied. Weak citrine ointment and red oxide mercury ointment are among the best. Solutions of nitrate of silver applied along roots of lashes are very useful. Refraction should always be carefully tested and corrected if at fault.

HORDEOLUM [Lat. *hordeolus*, *a stye*] or STYE: Is a boil affecting connective tissue near edge of lid. Sometimes several appear at once, and there is often a succession of them. They cause great swelling of lid, and considerable pain. When suppuration and sloughing occur some of the follicles are liable to be destroyed, and cicatricial deformity may be left. *Treatment*—Hot fomentations or small poultices

until pus forms, when tumor should be firmly grasped between thumb and finger, and opened by incision parallel to edge of lid. General health almost always requires attention. Styes sometimes seem to be *aborted*, if they are touched, when first noticed, by nitrate of silver, or some astringent ointment applied. Sometimes it is useful to incise them when they first appear.

CHALAZION [Gr. χαλαζα, *hail*]. TARSAL CYST :—Is occasioned by obstruction of orifice of sebaceous gland and retention of secretion. A tumor is thus formed in cartilage, generally about size of pea, and situated near conjunctival surface, so that it becomes prominent when lid is everted. Overlying skin of natural color and freely movable. If inflammation has occurred, cyst will contain pus ; otherwise it will be filled with gelatinous, fatty material. Several tumors may appear at same time. *Treatment*—To evacuate cyst through conjunctiva or skin according to circumstances. A free incision is made into tumor, and if contents are purulent they readily escape. If not, a curette should be introduced so as to empty sac. Curette should then be moved freely about, so as to excite inflammation of walls of sac and thus obliterate it.

The lids are subject to several deformities produced by chronic inflammation, and by ulcers, burns, injuries, &c., which cause loss of tissue and cicatricial contractions :

Horizontal cut, making wedge of the tissue with the lashes on it so then everting by union of the edges.

TRICHIASIS [Gr. *θριξ*, *hair*], is an inversion of the lashes so that they rub against eyeball.

DISTICHIASIS [Gr. *Διστιχια*, *a double row*], is same affection, except that there appear to be two rows of lashes. If condition has lasted long, cilia will be bleached by constant soaking in secretions, and may be easily overlooked.

ENTROPION [Eντροπη, a *turning toward*], is a turning in of free edge of lid against globe. It is sometimes spasmodic, from spasm of orbicularis, especially in old people with lax skin.

ECTROPION [Gr. Eκτροπη, *a turning from*,] is an eversion of lid, exposing its conjunctival surface.

All above conditions keep eye in state of constant irritation and discomfort. They are most commonly seen in the upper lid. A variety of operations are performed for their cure, a choice of which is determined by requirements of each case. In entropion temporary relief is obtained by pulling out inverted lashes by fine forceps (*epilation*), but they soon grow again. Mild cases may be relieved by removing an elliptical piece of the skin of the upper lid and uniting edges of wound by sutures. For bad cases in the upper lid Arlt's operation (*Arlt*, *Vienna*, 19*th cent.*) is one of the best. It is performed as follows :—The free margin of the tarsal cartilage is split into two layers, care being taken

to include all the hair-bulbs in the anterior layer. An elliptical piece of the skin and subjacent tissue of the anterior layer is then excised, and the edges of the wound united by sutures. This draws the ciliary margin of the anterior layer upward, transplanting it to a higher point.

PTOSIS [Gr. πτωσις, *falling*] is a drooping of upper lid, either partial or complete. Caused by injury of levator muscle; swelling, and increased weight of lid from inflammation; or by paralysis of 3d nerve (p. 138). Sometimes seen in old people from great relaxation of tissues. Rarely it is congenital.

PARALYSIS OF ORBICULARIS MUSCLE is a result of paralysis of *portio dura* of 7th nerve. Lids cannot be completely closed, and patient thus has a peculiar staring appearance called *lagophthalmos* [Gr. λαγως. *a hare*, and οφθαλμος, *eye*]. The lower lid falls away from globe so that tears run over, and eye suffers from constant exposure to external irritants.

BLEPHAROSPASM: A spasmodic contraction of orbicularis, so that lids are firmly pressed together against globe. Occurs where photophobia is marked, and presents all grades of severity. It is reflex from irritation of 5th nerve and occurs in neuralgia of its branches; in inflammation of conjunctiva or cornea; from foreign bodies; in hyperæsthesia of retina, &c. *Treatment* consists primarily in removing cause. Other remedies are hypo-

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dermic injections of morphia; immersion of head in cold water; canthoplasty; conium given until poisonous effect is obtained. In neuralgia of 5th, division of affected nerve sometimes practised.

NICTITATION [Lat. *Nictitatio*, *winking*.] A spasmodic contraction of orbicularis shown by frequent twitching and blinking of lids. Seen generally in weak and nervous patients.

ECCHYMOSIS of lids is effusion of blood into cellular tissue producing "black eye." Blood undergoes discoloration before it is absorbed, turning green, yellow, etc. To hasten absorption, cold applications, arnica lotion, and compress bandage are useful.

INCISED AND PUNCTURED WOUNDS, BURNS, etc., should be very carefully dressed, especially if they involve cartilage, lest deformity of lids may result from healing.

EPICANTHUS [Gr. επι, *upon*, and κανθυς, *angle of eye*]: Congenital malformation in which crescentic fold of skin passes from nose to eyebrows, overlapping inner canthus more or less.

COLOBOMA: Congenital fissure of lid; sometimes associated with coloboma of iris and choroid, hare-lip, cleft palate, etc.

LACHRYMAL APPARATUS.

STILLICIDIUM LACHRYMARUM [Lat. *stillicidium*, *dripping*, and *lacryma*, *tear*]: EPI-

PHORA [Gr. επι, *upon*, and φερω, *to bring?*]: WATERY EYE.—Is a condition common to nearly all lachrymal diseases. Caused by any impediment to efflux of tears through tear-passages, whether a simple displacement of puncta so that tears cannot enter them, or an obstruction in canaliculi, sac or ducts. Tears accumulate at inner angle of eye and flow over cheek, causing continual irritation and annoyance. Unless condition depends on some cause which can be otherwise removed, it must be remedied by operation. Method of opening canaliculi and probing nasal duct given at p. 70. Syphilis plays an important part in causation of lachrymal diseases, and should always be looked for.

DACRYO-CYSTITIS [Gr. Δακρυον, *tear*, κυστις, *bladder*]: ACUTE INFLAMMATION OF LACHRYMAL SAC:—ABSCESS OF SAC:—May result from conjunctivitis, nasal catarrh, exposure, injury, chronic disease of tear-passages, etc. Is attended by great pain, tenderness, redness and puffy swelling over sac and extending to lids. If disease progresses, skin becomes thinned and abscess bursts through it. *Treatment.*—Opening of canaliculus so as to give free exit for pus and prevent perforation through skin. If latter is imminent, free incision should be made through skin into sac, and kept open until abscess is completely drained. If perforation has already occurred,

canaliculus should be slit up and probes passed to open natural channels, and allow external opening to heal.

CHRONIC INFLAMMATION OF SAC : BLENORRHŒA OF SAC : MUCOCELE : [Gr. μυκος, *mucus*, and κηλη, *tumor*]. An insidious chronic inflammation of sac, resulting from acute or chronic inflammations of conjunctiva or nose, malposition of puncta, etc ; and nearly always associated with strictures of lachrymal passages. These are most frequent at junction of canaliculi with sac, but may occur at any other point. There is constant epiphora and irritability of eye. Swelling of sac varies, and, if it is pressed upon, viscid mucus oozes out through puncta. *Treatment* consists in opening canaliculi and relieving strictures of passages by probing or incision. Astringent fluids injected into sac sometimes of benefit. Treatment moderately successful, but must often be very protracted, and some cases never recover. For extremely troublesome cases, with caries of bones, an operation to obliterate sac is sometimes performed.

FISTULA OF THE LACHRYMAL SAC : is an external opening through skin, left generally by inflammation. Often associated with strictures of passages and caries of bone. *Treatment* aims to re-establish natural communica: tion through nose.

DISEASES OF THE LACHRYMAL GLAND are very rare. They comprise *inflammation of*

Hepar. Calc. Carb.

of meibomian glands - Lach. not needed, tears not needed.

gland, *dacryo-adenitis*, usually chronic : *cysts of gland*, *dacryops* [Gr. δακρυον, *tear*, and ωψ, *eye*], usually due to closure of excretory ducts and distention from secretion above : *fistula of gland*, generally resulting from abscess, dacryops or injury ; and *cancer*. Extirpation of gland is sometimes performed.

Rarely hypertrophy of gland - Ev.

ANOMALIES OF REFRACTION AND ACCOMMODATION.

The *refraction* of an eye is its faculty of bringing certain rays of light to a focus upon its retina without any effort of accommodation, and depends on the form of the globe and its refractive media.

The *accommodation* of an eye is its power of adjusting itself for vision at different distances—that is, for rays of different degrees of divergence. Nature of accommodation and method of measuring it given at p. 44

EMMETROPIA. E. [Gr. εν, *within*, μετρον, *measure*, and ωψ, eye]:—that state of refraction in which parallel rays are brought to a focus upon retina when eye is at rest.

HYPOMETROPIA or BRACHYMETROPIA [Gr. ὑπο, *under*, or βραχυς, *short*, μετρον, *measure*, ωψ, *eye*]: that state of refraction in which, with eye at rest, parallel rays are focussed *in front* of retina, only divergent rays being united upon latter. Usual name for this condition is

MYOPIA [Gr. μυω, *to wink*, ωψ, *eye*] from habit such patients have of nipping eyelids together to see more distinctly.

HYPERMETROPIA [Gr. ὑπερ, *beyond*, μετρον, *measure*, ωψ, *eye*]: that state of refraction in which, with eye at rest, parallel rays are focussed *behind* retina, only convergent rays being united upon latter.

ASTIGMATISM [Gr. α, *privative*, and στιγμα, *a point*]: that state of refraction in which, with eye at rest, rays from a point are not re-united in a point.

AMETROPIA [Gr. α, *privative*, μετρον, *measure*, ωψ, *eye*]: name applied to all refractive conditions which deviate from emmetropia.

ASTHENOPIA [Gr. ασθενης, *weak*, and ωψ, *eye*], or WEAK SIGHT; name for a group of symptoms often seen in the various refractive defects. After reading, writing, &c., for any length of time, letters become blurred and run into one another, eye grows red, watery, hot, painful and fatigued. Symptoms vanish when work is laid aside, to recur again as often as it is resumed. This may continue indefinitely until the cause is removed.

MYOPIA. M. (p. 149.) Caused generally by too great length of optic axis; exceptionally, by too high refractive power. Often hereditary or congenital; may be acquired from prolonged straining at fine work. Is stationary or progressive; in former case,

generally of low degree and causes little annoyance; high grades apt to be progressive, and, if so, are associated with marked irritation and asthenopia. Far-point of distinct vision lies nearer eye than it should. Beyond this point, all objects appear indistinct. Far-point expresses degree of the M; for instance, if patient cannot see clearly beyond 24 inches he is said to have M $\frac{1}{24}$. To see distant objects, the rays, before entering his eye, must be made to diverge as if they came from a point 24 inches away, as thus only can they be united on his retina. This is done by concave glass of 24 inches focus. With ophthalmoscope, details of fundus of a highly myopic eye can be seen by direct method at some distance away; and if head is moved to one side objects of fundus are seen to move in contrary direction. This is due to fact that, in such cases, an aerial image of fundus is formed by refractive media of eye itself at distance corresponding to M. For example, in M $\frac{1}{3}$, at 3 inches in front of eye. To get clear view of fundus in erect image, a certain concave glass must be used behind mirror. Focal length of this glass, *plus* its distance from nodal point of observed eye, equals the M. By indirect method, disc and vessels appear smaller than in E. Posterior staphyloma is often seen around disc, and is called *myopic arc* or *crescent* (p. 109).

Treatment. General directions are to avoid

everything which tends to congest eyes, such as reading in stooping or recumbent posture, by faulty light, &c. Refraction is corrected by concave glasses which render parallel rays divergent enough to be united on retina. It is the rule to give the weakest glass with which best vision is obtained. Myopic eyes frequently amblyopic also.

HYPERMETROPIA. H. (p. 150). Caused generally by optic axis being too short; exceptionally by refractive power being too low. May be congenital and hereditary: is acquired by senile changes in eye and by aphakia. Eye cannot see distant objects clearly without using a convex glass, or (what amounts to same thing) a certain amount of accommodation. Nearer the object, greater the strain upon accommodation. This leads to overtaxing of ciliary muscle and asthenopia, if eyes are much used at fine work. May also cause strabismus (p. 134).

Manifest H: is that which is evident without paralysing accommodation.

Latent H: that which is habitually concealed by accommodation, but appears after latter has been paralysed by atropine. Latent H tends to become manifest as age advances.

Facultative H: that variety in which patient can see different objects clearly with or without convex glasses, and can do fine work easily without glasses.

Relative H: far and near objects are clearly seen, but only by converging visual lines to point nearer than object—by giving eyes periodic squint.

Absolute H: neither near nor distant objects can be seen clearly without convex glasses.

The strongest convex glass through which patient obtains his maximum acuteness of vision for distant objects represents his manifest H. If accommodation is paralysed by atropine, the strongest convex glass which gives greatest acuteness of vision represents total H, including latent, if any existed. With ophthalmoscope, details of fundus may be seen by direct method some distance away, and if head is moved to one side they are seen to move in same direction. On going closer, a certain convex glass will be needed behind mirror to get a clear erect image: and focal length of the glass, *minus* its distance from nodal point of observed eye, equals exact degree of H. Field of vision larger and image smaller than in E. By indirect method, disc and vessels look larger than in E.

Treatment consists in correcting refraction by suitable convex glasses. In manifest H. it is the rule to give the strongest glass with which the patient gains most distinct vision. In latent H. it is usually necessary to begin with a weak glass and advance gradually to the fully-correcting one.

Astigmatism. As. (p. 150): depends on want of symmetry in refracting surfaces, so that refraction differs in different meridians, and retinal image is thus confused. Generally congenital, and may be hereditary; is acquired, by inflammation of cornea, faulty union of corneal incision after an operation, use of improper glasses, &c. Meridians of greatest and least curvature are called *chief* or *principal meridians*. Astigmatism caused by different focal lengths of principal meridians is called *regular*. That caused by differences of refraction in same meridian is called *irregular*. Latter form comes from irregularities in structure of lens or cornea, either original (*normal irregular astigmatism*) or acquired through disease (*abnormal irregular astigmatism*). Chief subjective symptom is monocular polyopia (eye seeing more than one image), and metamorphopsia. Objective symptoms are irregular corneal reflections and changes of curvature, sometimes visible by oblique illumination, distorted appearance of objects of fundus, with parallax. Irregular astigmatism cannot be corrected by glasses, but is sometimes improved by stenopæic apparatus. Regular astigmatism is *simple* when one chief meridian is emmetropic and the other ametropic; *compound* when both are myopic or hypermetropic, but defect is greater in one than the other; *mixed* when one chief meridian is myopic and the other

hypermetropic. Astigmatism is corrected by means of cylindrical glasses (p. 47). (All eyes are naturally astigmatic, the curvature being slightly stronger in vertical than in horizontal meridian. No inconvenience is felt unless As. is more than $\frac{1}{40}$.)

PRESBYOPIA. Pr. [Gr. πρεσβυς, *an old man*, ωψ, *eye*] : FAR SIGHT : Name applied to condition of diminished range of accommodation seen in elderly people. Consists in a recession of the near-point and is due to increased firmness of lens, so that accommodative act can no longer render it as convex as before. First symptom is that small objects cannot be seen clearly at so short a distance as formerly, but must be held further away from eye, especially in evening. Distant vision, however, remains unimpaired. Recession of near-point begins in all eyes in youth and gradually progresses during life. Does not usually cause inconvenience until after 40. Appears earlier in hypermetropic eyes. *Presbyopia* is assumed to begin when near-point has receded beyond 8 inches. Degree of Pr. is found by deducting patient's near-point from this. Thus, if p lies at 16 inches, Pr. $=\frac{1}{8}-\frac{1}{16}=\frac{1}{16}$. Pr. is easily corrected by convex glasses for reading, and they should be given as soon as the affection appears. Usual to give weakest glass which renders work comfortable at proper distance.

Differences in the refraction of the two eyes often occur and are of great variety. Adjustment of glasses to such cases is largely a matter of experiment. As a rule, glasses which differ by more than $\frac{1}{40}$ are not well borne.

APHAKIA [Gr. *a*, *privative*, and *φακος*, *lens*]; ABSENCE OF CRYSTALLINE LENS: May be congenital or result from absorption of lens after injury, removal by operation, or dislocation. Refractive power of eye thus very much lessened. Accommodation, as a rule, entirely absent. Exceptional cases have occurred where some accommodation remained in lensless eye. Very strong convex glasses required for close work, and somewhat weaker ones for distance. When lens is gone natural corneal astigmation becomes apparent.

PARALYSIS OF ACCOMMODATION sometimes seen in general debility of system, especially after diphtheria. May be complete or partial. Is usually attended by dilatation of the pupil. Causes marked inconvenience in emmetropic eyes, as the recession of the near-point renders the patient unable to do any close work. Distant vision, however, is not impaired. In hypermetropes, both near and distant vision are disturbed. In myopes the impairment of vision is less, as they are

still able to see clearly at their far-point, which may be only a few inches from the eye, *e.g.*, in M$\frac{1}{12}$. Convex glasses restore the vision for near objects at once. Diagnosis is easily made if range of accommodation is tested. *Treatment* consists primarily in removing any apparent cause—such as general debility. Iodide of potash sometimes useful. Calabar bean, locally, may be beneficial.

SPASM OF CILIARY MUSCLE (*apparent myopia*): Sometimes occurs in ametropia, especially in H., following upon undue straining of accommodation. May be associated with contracted pupil. Causes asthenopia and dimness of vision for distant objects. Latter is perfectly relieved by weak concave glasses. The true state of refraction may be found by the ophthalmoscope; or, if there is doubt, atropine may be used. *Treatment*: strong sol. atropine until spasm is completely overcome.

SIMULATED BLINDNESS: Often met, and sometimes very difficult to detect. Simulated blindness of one eye may be detected by holding a prism before healthy eye, when, if patient sees two images, simulation is proved. If eye is truly blind, pupil should be partly dilated and insensible to light when healthy

eye is closed; but when latter is exposed to light both pupils should contract together. Stereoscope also used, with slides having two different kinds of print or figures upon them, which are so arranged as to undergo a transposition when seen through the instrument. Thus, if patient is simulating blindness of his right eye, he will naturally say that he sees only the left-hand figure in the ophthalmoscope; but this really belongs to the right eye, and so the fraud is exposed. Various trials with test-types and glasses (noticing whether patient's statements are consistent) are useful. When atropine has been put into eye for deception, pupil is noticed to be dilated *ad maximum*, and does not act with that of other eye. In absolute blindness of both eyes, pupils should not contract under bright light.

PHOTOPSIA [Gr. φως, *light*, and οψις *sight*]; PHOSPHENES: Flashes of light, fiery sparks, luminous rings, etc., which patients describe as seen before their eyes. They occur in retinal inflammations, after blows upon eyes, etc. Also occur in blind eyes.

MICROPSIA [Gr. μικρος, *small*, and οψις, *sight*]: Objects appear smaller than they really are. Occurs in diseases which disturb rods and cones of retina.

METAMORPHOPSIA [Gr. μεταμορφοω, *to transform*]: Objects appear distorted. Occurs in retinal disease and in irregular astigmatism.

COLOR-BLINDNESS; DALTONISM. [After chemist Dalton, who first described it.] Is an inability to distinguish colors, and is of variable degree. Congenital, or result of disease, especially of atrophy of optic nerve. May also be produced by long-continued strain of eyes in working at colors. If only two of the primary colors can be seen, condition is called *dichromic vision*. Where no color can be distinguished, condition is called *achromatic vision*.

PART II.

OTIC MEMORANDA.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE EAR.

THE auditory apparatus consists of a complicated structure (*the ear*) for collecting sonorous impressions, and conveying them to the auditory nerve, which transmits them to the brain. Delicate parts of the ear are securely imbedded in the petrous portion of the temporal bone. The sound-waves are collected by the auricle, conveyed through the ext. auditory canal, and received upon the membrana tympani, which is thrown into corresponding vibrations. These vibrations are conveyed by the chain of bones through the tympanum to the fluid of the labyrinth, and so to the terminal auditory nerves. The impressions there received are transmitted to the brain, where they are perceived as *sound*. The membrana tympani is so arranged as to undergo variations of tension in accordance with the different kinds of waves which strike it. The pressure of the air in the tympanic cavity is regulated by its communications with the mastoid cells, and with the pharynx through the Eustachian tube. The component parts

of the terminal auditory apparatus in the cochlea are supposed to be tuned to vibrate in sympathy with all the different notes which are appreciable in our musical scale. The semicircular canals have been considered as governing the equilibrium of the body and as having little or no part in function of hearing. [Buck suggests that they may serve as safety-valves to protect the terminal apparatus from injury in cases of very loud or sudden noise, where the stapes is driven violently against the fenestra ovalis.] Our knowledge of the physiology of audition is still incomplete on several points.

THE ANATOMY OF THE EAR may be conveniently divided, for the sake of description, as follows :—

I.	EXTERNAL EAR.	(a) *Auricle.* (b) *External auditory canal.*
II.	MIDDLE EAR.	(a) *Membrana tympani.* (b) *Cavity of tympanum.* (c) *Mastoid cells.* (d) *Eustachian tube.*
III.	INTERNAL EAR.	(a) *Vestibule.* (b) *Semicircular canals.* (c) *Cochlea.* (d) *Auditory nerve.*

EXTERNAL EAR.

Auricle [Lat. *auris*, *ear*] or *pinna* [Lat. *pinna*, a *mussel*] :—is external funnel-shaped ap-

pendage fastened to malar and temporal bones by elastic fibres. Has fibro-cartilaginous framework closely covered by perichondrium and skin. Latter forms projection from lower end of cartilage called *lobe* of ear. Outer edge of auricle called *helix* [Gr. ἑλίσσω, *to twist*]. Within helix is *fossa navicularis* [Lat. *navicula*, *small boat*]. At inner edge of this is another ridge, *the anti-helix*. In front of opening of auditory canal is projection called *the tragus* [Gr. τραγος, *goat:* because hairs like goat's beard usually grow here ?] Opposite this on other side of canal is similar projection, *the anti-tragus*. Concavity around orifice of canal called *the concha*. [Gr. κόγχη, *concave shell*.] Above this is triangular depression, *the fossa triangularis*. Skin of auricle covered by downy hairs, and contains sebaceous glands (largest in concha), and sweat-glands (chiefly on side next skull).

Muscles of Auricle.

Levator or *attolens aurem :* O. aponeurosis occipito-frontalis. Fan shape. Fibres converge to I. at upper part of auricle. Lifts auricle. Supplied by small occipital nerve.

Attrahens aurem : O. lateral edge aponeurosis occipito-frontalis. I. in front of helix. Draws auricle forward and upward. Supplied by facial and auriculo-temporal branch of inf. maxillary nerve.

Retrahens aurem : O. mastoid process by short aponeurotic fibres. I. lower part cranial surface of concha. Draws auricle backward. Supplied by post. auricular nerve from facial.

[Above muscles rudimentary in man.]

Intrinsic muscles : muscles of animal life. Slightly developed ; sometimes absent :—

Tragicus : lies on ant. surface ant. wall of cartilage auditory canal.

Anti-tragicus : lies on post. surface post. wall of cartilage auditory canal.

Helicis major : runs over ant. margin helix and passes into levator aurem.

Helicis minor : lies on lateral surface helix between its root and spine.

Transversus auriculæ : runs on post. surface auricle from navicular fossa to concha, across furrow corresponding to anti-helix.

Obliquus auriculæ : runs on post. surface auricle over furrow corresponding to lower root anti-helix.

Dilator of concha : on tragus.

Arteries of Auricle.

Post. auricular from ext. carotid

Ant. auricular from temporal.

Auricular branch from occipital.

Veins empty into temporal, ext. jugular and post. facial.

Nerves of Auricle.

Auriculus magnus, from cervical plexus, on post. surface auricle. *Post. auricular* from facial. *Auricular branch* from pneumogastric. *Auriculo-temporal branch* from inf. maxillary.

External auditory canal. Meatus auditorius externus [Lat. *equiv.*]:—Runs from auricle to membrana tympani, forward and inward, crooked course, principal curve having convexity upward, so that canal is higher in middle than at either end. Average length about 1 in. Width varies; widest parts at junction of bone and cartilage, and close to membrana tympani. Outer $\frac{1}{3}$ cartilaginous, continuous with cartilage of auricle, and interrupted by fissures, *incisuræ Santorini*, filled with fibrous tissue. Inner $\frac{2}{3}$ bony, part of temporal bone. [Sup. and post. walls developed from temporal bone in general growth of skull; ant. and inf. walls from tympanic ring or *annulus tympanicus* [*Lat. equiv.*] of fœtus,—an oval bony ring, with upper $\frac{1}{4}$ wanting, which is independent at first but finally joins with rest of bone. At birth, no bony canal exists, it being represented by membrane, which disappears as bone grows outward.] At bottom of canal, in annulus tympanicus, is tympanic groove *sulcus tympanicus*, [*Lat. equiv.*] for insertion of membrana tympani. Groove and ring interrupted above by a segment of irreg-

ular outline, about $\frac{1}{10}$ in. high and $\frac{1}{8}$ in. wide, the *segment of Rivinus* [Rivinus, Leipsic, 18*th cent.*] Each end of segment marked by projecting bony spine. Helmholtz [*Berlin*, 19*th cent.*] calls ant. point *spina tympanica major* (*spina tymp. posterior* of Henle) and post. one, *spina tympanica minor*. Owing to oblique position of membrana tympani, ant. and inf. walls of canal are longest. (p. 169). Canal lined by integument containing soft hairs, sebaceous and ceruminous glands. Latter are like sweat-glands. *Cerumen* [Lat. for *wax*] consists chiefly of fat and coloring matter. Integument becomes thinner as it approaches membrana tympani. Canal in relation in front with articulation lower jaw; in front and below with parotid gland: behind with mastoid cells and transverse sinus: above with mastoid cells, dura mater, and middle fossa of skull.

Vessels:—Post. auricular artery; deep auricular from int. maxillary, entering at articulation lower jaw. Largest vessels run on upper and post. walls.

Nerves from 3d branch 5th and from pneumogastric, entering through ant. wall.

MIDDLE EAR.

Membrana tympani or *Drum-head.* Lies at bottom of ext. auditory canal, separating it

from tympanic cavity. Placed obliquely, forming acute angle (45°) with inf. and ant. walls of canal and obtuse one with sup. and post. walls. Upper border about $\frac{1}{4}$ in. nearer to entrance of canal than lower ; post. border about $\frac{1}{5}$ in. nearer than ant. [In infant lies more horizontally and nearly in line with upper wall of canal.] Of ellipsoidal shape with long axis (about $\frac{1}{3}$ in.) downward and forward. At upper part presents conical protrusion,—apex corresponding to short process of malleus, and base spreading out in front and behind, forming *anterior* and *posterior folds*, anterior being the shorter one. General position of membrane is arched, with concavity outward. Deepest concavity surrounds end of malleus-handle and is called *the umbo* [Lat. for *boss*, of a shield.]. Membrane inelastic, about $\frac{1}{250}$ in. thick, and composed of 3 layers :—a middle fibrous layer, covered externally by skin of auditory canal, and internally by mucous memb. of tympanum. Dermoid layer very thin and devoid of hairs and glands. Middle layer, *lamina propria* presents two layers of fine fibres, an outer *radiating* and an inner *circular*. In ant. half of memb. outer fibres radiate from tip of malleus as centre ; in post. half they radiate from entire length of malleus-handle. In centre of memb. circular fibres form very thin layer which grows thicker towards periphery and there becomes thin again or disappears. Between

some of the fibres are cells—*corpuscles of Von Tröltsch.* [*Anton Von Tröltsch*, Würzburg, 19th cent.]. Short process and handle of malleus embedded between radiating and circular fibres (p. 174). On tympanic side of memb. is fibrous fold $\frac{3}{25}$–$\frac{4}{25}$ in. high and $\frac{4}{25}$ in. broad, running from post. and sup. border of bony ring (p. 167) to handle of malleus, forming a pocket opening downward. Called *the posterior pouch.* There is similar space in front of malleus, *the anterior pouch*, formed by spina tympanica major (p. 168), long process malleus, mucous memb., ant. ligament malleus, chorda tympani nerve and inf. tympanic artery. At margin of drumhead, its layers unite to form tendinous ring, which is inserted into sulcus tympanicus (p. 167). Tendinous bands run from end of Rivinian segment to short process of malleus, and above these is triangular space, including Rivinian segment, and filled by dermoid and mucous layers, more flaccid than remainder of membrane. Called *membrana flaccida* or *Shrapnell's membrane* [H. J. Shrapnell, London, 18th cent.] Minute opening supposed by some to exist in this part called *Rivinian foramen.*

Blood-vessels : To outer layer from deep auricular artery. To inner, from vessels of tympanum. Two layers communicate by capillary network in middle layer.

Nerves in all layers : In outer, from super-

ficial temporal of 5th. In inner, from tympanic plexus and nerves of cutis.

Lymph vessels found in all layers.

Seen through the auditory canal, the normal memb. tympani presents a delicate, bluish-gray color and is quite translucent. Short process of malleus appears as a whitish tubercle at upper border, and handle of malleus as a whitish stripe running from this down and back towards the centre of the memb., dividing it into ant. and post. parts, of which the former is the larger. *The "light-spot"* is a bright, triangular reflection with its apex towards the tip of the malleus-handle and base ($\frac{1}{25}$–$\frac{1}{15}$ in. broad) towards the periphery of the memb. It results from the oblique position of the memb. and from its marked concavity at this point. Sometimes one or two fine vessels may be seen, especially along the malleus-handle.

Cavity of tympanum or *drum of the ear.* [Lat. *tympanum, drum*] :—Irregular, air-containing space lying behind drum-head. Lined by mucous membrane continuous with that of Eustachian tube and pharynx. Average diameters; antero-posterior $\frac{1}{2}$ in.; anterior vertical $\frac{1}{5}$–$\frac{1}{3}$ in.; post. vertical $\frac{3}{5}$ in.; anterior transverse $\frac{1}{8}$–$\frac{1}{6}$ in.; transverse opposite drumhead $\frac{1}{12}$ in. Folds of mucous memb. stretch from one bony point to another, in some places

forming prominent ridges. *Anterior wall* presents, at its upper part, the opening of the Eustachian tube. Canal for tensor tympani muscle lies above Eustachian tube, separated from it by thin plate of bone, *septum tubæ*, which ends by small projection into tympanum, *processus cochleaformis*. *Posterior wall* separates tympanum from mastoid cells and presents openings into cells at upper part, close under roof. *Outer wall* composed mostly of drumhead, but extends further backward than this ; presents 3 openings :—(1), *iter chordæ posterius*, [Lat. *iter*, *a path*,] on level with centre of drumhead and close to its post. edge, the opening of a minute canal which descends in front of Fallopian canal and finally joins it. Chorda tympani nerve enters here, runs up under long process of incus on free edge of post. pouch, then forward across neck of malleus, and leaves tympanum by (2) *iter chordæ anterius*, or *canal* of *Huguier*, situated just in front of memb. tympani and running parallel with (3) *Glaserian fissure*, opening above and in front of memb. tympani, receiving long process malleus, ligament mallei anterius and tympanic artery. *Inner wall* forms outer wall of labyrinth. Presents : *fenestra ovalis* [Lat. for *oval window*], an oval opening, $\frac{1}{15}$ in. high, opposite upper part of drumhead and leading into vestibule. Closed by membrane, on which rests base of stapes. A smaller opening below latter, *fenestra ro-*

tunda [Lat. for *round window*], $\frac{1}{12}$ in. diameter, leading into cochlea. Closed by membrane called *membrana tympani secundaria.* In front of fenestræ and extending between them is a rounded projection, *the promontory*, corresponding to first whorl of cochlea. Presents grooves for nerve-twigs. In front of promontory wall very thin and covers carotid artery. Above and behind fenestra ovalis is a ridge corresponding to *Fallopian canal* which contains facial nerve. Behind and below fenestra ovalis is *the pyramid*, or *eminentia Stapedii*, a conical eminence containing circular canal which encloses stapedius muscle and communicates below with Fallopian canal. On level with fenestra ovalis and behind ridge of Fallopian canal is a smooth surface corresponding to horizontal, semicircular canal. *Upper wall* very thin (sometimes wanting) and separates tympanum from cranial cavity. *Lower wall*, sometimes very thin or wanting, separates tympanum from jugular vein. Pierced by glosso-pharyngeal nerve.

The Ossicles of the Ear, or *Ossicula auditus* [*Lat. equiv.*] : are three small bones—*malleus* [Lat. for *hammer*], *incus* [anvil], and *stapes* [stirrup], which form a chain across tympanum. Covered by very thin periosteum and mucous memb. *Malleus* presents head, neck, short process, handle or *manubrium* [Lat. for

handle], and long process, processus gracilis or Folianus. Handle and short process attached to middle layer of drumhead (p. 170). Attachment firm at end of handle, looser about short process, leaving sort of joint-space there. Long process runs forward and outward toward Glaserian fissure. Said by some to be dwindled to a short stump in adults. Head and neck of malleus attached by ligamentous fibres. Those running from spina tympanica major to neck of hammer and enveloping long process up to Glaserian fissure, called *ligamentum anterius mallei*. Those radiating from neck of malleus to border of Rivinian segment, *ligamentum mallei externum*. Those running from head of malleus to roof of tympanum, *ligamentum mallei superius*. Most posterior group of fibres of ligamentum externum called *ligamentum posticum*, and this with middle group of ligamentum anterius is called *axis-band* of hammer. (Helmholtz.) Head articulates with incus by peculiar joint containing *cog*, which allows malleus to rotate outward, but prevents it from rotating inward without carrying incus with it. *Incus* presents head, long and short process. Head articulates with malleus. Joined to tympanic roof by *ligamentum incudis superius*. Short process runs back and articulates with post. wall tympanum. Long process descends parallel with and behind handle of malleus and ends in lens-shaped tip, which articulates

with head of stapes. Joint is flat segment of sphere, convex toward stirrup. *Stapes* presents head, neck, crura, and base. Head articulates with incus. Base is surrounded by lip of fibro-cartilage and rests in fenestra ovalis ; union between it and wall of vestibule is by periosteum of latter extended over base. A thin membrane inserted into side of base and inner edges of crura, closing opening between them, is called *ligamentum obturatorium stapedium*. Joints of ossicles provided with articular cartilages and capsules. *Tensor tympani muscle* arises from periosteum of upper wall of canal in which it lies, from upper wall of cartilage of Eustachian tube, and from neighboring border of sphenoid. Before leaving canal it becomes tendinous, and tendon turns around processus cochleaformis (p. 172) at nearly right angle, to be inserted into ant. half of inner side of hammer at beginning of handle and a little below short process. Supplied by nerve from otic ganglion. Draws handle of hammer inward and renders memb. tympani tense, and all the ligaments of the ossicles (except superius mallei) are simultaneously put on the stretch ; at the same time the long process of the anvil is made to rotate inward with the malleus handle, and so to press the stirrup against the oval window and fluid of the labyrinth. *Stapedius muscle* arises from cavity in *pyramid* in which it lies. Tendon leaves canal at obtuse angle

and is inserted into neck of stapes. Supplied by nerve from facial. Supposed to depress base of stapes, and so compress contents of labyrinth.

Arteries of tympanic cavity: Tympanic branch int. maxillary, entering by Glaserian fissure. Stylo-mastoid branch post. auricular entering by stylo-mastoid foramen. Petrosal branch middle meningeal entering by hiatus Fallopii. Branches from ascending pharyngeal and int. carotid entering by median wall Eustachian tube.

Veins empty into mid. meningeal and pharyngeal.

Nerves: To muscles, *q. vide.* To mucous memb. from *tympanic plexus*, which is formed from tympanic branch (Jacobson's nerve) of petrous ganglion glosso-pharyngeal, entering by small foramen below promontory; from branch of superficial petrosal, entering from above; and from branches from carotid plexus of sympathetic entering through wall of carotid canal. The *otic ganglion:* situated near foramen ovale of great wing of sphenoid, in front of middle meningeal artery, on outer side of cartilage of Eustachian tube and origin of tensor palati muscle, and internal to inf. maxillary nerve. Receives fibres from 3d division of 5th, from auriculo-temporal, and from sympathetic plexus around mid. meningeal artery. Communicates with glosso-pharyngeal and facial nerves through small petrosal. Sends

branches to tensor tympani and tensor palati muscles. *Chorda tympani nerve* passes across tympanum (between handle of malleus and long process of incus and along lower margin of post. pouch of memb. tympani), but seems to have no physiological relation to it.

The mastoid cells consist of a large number of irregular cells, of varying size, contained in mastoid process of temporal bone. Whole are surrounded by dense cortical layer of bone $\frac{1}{25}$—$\frac{1}{12}$ in. thick. In upper part of process there is a single large cell, *the mastoid antrum* [Lat. *antrum*, *cave*], which communicates with lower cells, and from which one or more openings lead into tympanum through its anterior wall. Cells are lined by thin mucous membrane. [At birth mastoid process is rudimentary, and contains only one large cell, which corresponds to antrum.] *Vessels* of cells from stylo-mastoid branch of post. auricular. *Nerves* from tympanic plexus,

The Eustachian Tube [Eustachius, Venice, 16th cent.] :—Leads from pharynx upward, outward and backward to tympanum, at angle 135° with axis of ext. auditory canal. Consists of cartilaginous and bony portion, whole length being about $1\frac{2}{5}$ in. Tympanic end is bony ; triangular shape ; about $\frac{1}{2}$ in. long and $\frac{1}{12}$ in. diameter. Outer wall belongs to *pars tympanica*, median wall separates tube from carotid canal, and upper wall, *septum tubæ*,

from canal of tensor tympani muscle. Point of union with cartilage is jagged, and median wall runs further back than outer. Cartilage of tube consists of two plates, a *median* triangular one, which is the larger, and into whose upper and outer part is inserted the smaller, hook-shaped *outer* one, which is attached to base of skull. Remaining wall of this part of tube (equal to about half its circumference) is formed of membrane. Narrowest part of tube is at *isthmus*, the junction of cartilaginous and bony parts. Pharyngeal orifice is trumpet-shaped, about $\frac{1}{3}$ by $\frac{1}{6}$ in. diameter, and lies in post. nasal space a little above floor of nostril. Inner wall projects slightly into pharynx so that mouth of tube lies rather in a frontal plane. Tube lined with mucous memb., which in bony part adheres very closely to periosteum. Contains numerous acinous glands, which decrease toward tympanic end. Memb. quite thick at pharyngeal end. Epithelium ciliated, with motion of cilia toward pharynx.

Muscles of tube: Abductor or *dilator of tube* (*spheno-salpingo-staphylinus*, *circumflexus palati*, or *tensor palati mollis*): O. sphenoid bone and cartilage of tube. I. convex border of outer cartilage along its whole length. Fibres pass forward, inward and downward, and spread over edge of soft palate and side of pharynx. Draws hook of outer cartilage forward and downward, enlarging

calibre of tube. Fibres said to pass into those of tensor tympani. Supplied by internal pterygoid nerve.

Levator veli palati: O. lower surface of temporal bone on ant. border of entrance to carotid canal, and from cartilage of tube. I. in region of osseous tube on bone, cartilage and mucous memb. of tube. Presses membranous floor of tube forward, enlarging transverse diameter. Supplied by pneumogastric nerve.

Salpingo-pharyngeus: Thin muscular layer connected to lower end of median cartilage, to mucous memb. and post. wall of pharynx. Considered as fixator of median cartilaginous plate. Called fascia by some.

Vessels of tube: Ascending pharyngeal from ext. carotid. Middle meningeal from int. maxillary. Branch from int. carotid.

Nerves of tube:—Branches to muscles *q. vide.* Sup. pharyngeal from 5th. Glosso-pharyngeal.

Whether tubes are normally open or closed is disputed. They are opened during act of swallowing. A semi cylindrical space under hook of cartilage is called *safety-tube*, and supposed to be always open.

INTERNAL EAR, OR LABYRINTH.

Is the essential part of the hearing apparatus, containing the ultimate filaments of the

auditory nerves. Comprises several osseous cavities contained in the petrous bone, within which are corresponding membranous sacs, receiving the distribution of the nerve. Sacs and intervening spaces are filled with a clear fluid.

BONY CAVITIES are: (1) *Vestibule.* (2) *Semicircular canals.* (3) *Cochlea.*

VESTIBULE:—Irregular ovoid shape; diameters from above downward and from behind forward about $\frac{1}{5}$ in., and from without inward about $\frac{1}{10}$ in. *Outer or tympanic wall* contains *foramen ovalis* (p. 172); above this, is anterior opening of horizontal semicircular canal. On *inner wall*, near upper ant. edge, are two depressions, *recessus ellipticus* and *recessus sphæricus;* small ridge separating them called *crista vestibuli;* crista runs above into pyramidal elevation, *pyramis vestibuli;* below, it divides into two branches, which enclose a space called *recessus cochlearis;* recessus ellipticus is partly bounded below by a shallow furrow, *sinus sulciformis;* just above recessus, ampullar orifice of ant. vertical semicircular canal opens; at post. part of inner wall is opening of *aqueductus vestibuli*, a fine canal running into vestibule from post. surface of petrous bone; contains tubular prolongation of lining memb. of vestibule ending in the cranium between the layers of the dura mater. At junction of inner and post. walls is opening common to both vertical semi-

circular canals. At same level in middle of post. wall is post. opening of horizontal semicircular canal. In angle of post. lower and inner walls is lower opening of post. vertical semicircular canal. On ant. apex of vestibule below recessus sphericus, and below ant. edge of fenestra ovalis, the scala vestibuli of the cochlea begins (p. 184). *Maculæ cribrosæ* [Lat. *macula*, *spot*, and *cribrum*, *a sieve*], for entrance of twigs of auditory nerve are on inner wall, but are only visible by microscope in adult. Each macula consists of a group of fine holes. The largest one, *macula cribrosa superior*, lies at upper end of crista vestibuli, and admits nerves to utricle and to ampulæ of ant. vertical and horizontal semicircular canals. *Macula media* lies in recessus sphericus, and admits nerves to saccule. *Macula inferior* lies at ampullar opening of post. vertical semicircular canal, and admits nerves to ampulla. A fourth macula lies in upper part of recessus cochlearis, and admits twig of cochlear nerve to septum between utricle and saccule.

SEMICIRCULAR CANALS: are C-shaped, starting from vestibule and returning to it again. Horizontal one convex laterally. Other two are vertical (anterior and posterior) at right angles to each other. Five openings in all, one being common to both vertical canals. For situation in vestibule *vide* p. 180. Openings called *ampullæ*, from flask-shape.

[Lat. *ampulla*, *flask*.] Dimensions vary. Length of ant. vertical $\frac{4}{5}$ in. Of post. vertical about $\frac{1}{12}$ in. Of horizontal about $\frac{1}{5}$ in. Part common to both vertical canals, *canalis communis*, about $\frac{1}{12}$–$\frac{1}{8}$ in. long. Average diameter of canals $\frac{1}{20}$–$\frac{1}{15}$ in. Openings of ant. vertical canal close together, at about same height; those of post. vertical stand one above the other; those of horizontal close to those of ant. vertical.

COCHLEA:—So called from resemblance to snail [Lat. *cochlea*, *snail*.]. Is a tube which coils around a central pillar or axis and tapers toward one extremity, where it ends in a *cul-de-sac*. About $1\frac{1}{2}$ long, $\frac{1}{10}$ in. diameter at beginning and $\frac{1}{20}$ in. at end. Makes $2\frac{1}{2}$ turns from below upwards, from left to right in right ear, and *vice versa* in left. Apex, or *cupola*, directed forwards and outwards, with vaulted roof. Cochlea is separated in front by a thin wall from carotid canal. Inwards, it strikes upon blind end of internal auditory canal. Encroaches as *promontory* on inner wall of tympanum. *Axis*, *spindle*, or *modiolus*, [Lat. *modiolus*, *hub of a wheel*,] is composed of inner walls of tube and of central spongy bone-substance circumscribed by its turns. Diminishes from base to apex, being about $\frac{1}{8}$ in. diameter at former and $\frac{1}{50}$ in. at latter. Length about $\frac{1}{6}$ in. Base rests upon bottom of internal auditory meatus. Apex forms inner wall of last half whorl, ending in a thin lamel-

la-like section of a funnel, called *infundibulum* [Lat. for *funnel*]. Spongy substance is penetrated by numberless small canals which run outwards from base to spiral lamina, and allow passage of nerves and vessels from *meatus auditorius internus*. Two of the canals running in spongy substance have names. Their walls are perforated by fine holes corresponding to canals running to spiral lamina. One, *canalis centralis modioli*, begins in fossa cochlearis and runs in axis of modiolus from base to apex. The other, *canalis spiralis modioli*, or *canalis ganglionaris*, runs spirally along outer wall of modiolus at line of junction of lamina spiralis: oval form, separated from scala tympani by thin, cribriform lamella, and ends at apex near hamulus. Canals transmit vessels and nerves. In canalis spiralis lie ganglia of cochlear nerve. On outer surface of modiolus, and running spirally around its axis from base to apex, is a projecting bony ledge called *lamina spiralis ossea*. Made up of two lamellæ which at its base, where they come off from wall of modiolus, enclose spongy bone-substance, communicating with canalis spiralis modioli. Its free edge, where lamellæ approach each other, is thinner. Post. lamella forms outer wall of canalis spiralis ; anterior passes into wall of scala vestibuli. Lamina diminishes in width and thickness towards apex. In first whorl, projects into tube of cochlea $\frac{1}{20}$ in., in last

whorl $\frac{1}{50}$ in. At apex ends in bony hook, the *hamulus* [Lat. for *small hook*], projecting into cupola. The *ductus cochlearis* or *lamina spiralis membranacea* stretches from free edge of bony lamina across to outer wall of cochlear canal. A complete partition is thus formed dividing canal into two passages or *scalæ* [Lat. for *stairway*]. Lower scala has its base turned towards tympanum striking upon memb. tympani secundaria, and is called *scala tympani*. Upper one alone opens into vestibule (by recessus sphericus) and is called *scala vestibuli*. At apex of cochlea the two scalæ open into each other from fact that lamina spiralis ends in last half coil of canal; communication called *helicotrema* [Gr. ἑλισσω, *to twist*, and τρημα, *hole*]. [Communication doubted by Buck]. Two small canals open by one end into labyrinth and by the other on surface of petrous bone: (1.) *Aqueductus vestibuli*, about $\frac{1}{5}$ in. long, begins by groove just below and in front of opening of the two vertical semicircular canals, runs around inner wall of common canal, then down and back, and opens under bony projection a little behind middle of post. inner surface of petrous bone. Transmits small vein carrying blood from semicircular canals and emptying into vein of dura mater or into inf. petrosal sinus. (2.) *Aqueductus cochleæ* is somewhat larger; begins by small orifice in lower wall of scala tympani, just above fenestra rotunda, runs

downwards, inwards and forwards in inner wall of jugular fossa, and opens at bottom of triangular depression towards middle of edge, which limits inner and inf. surface of petrous bone. Transmits vein carrying blood from cochlea and empyting into jugular.

The *periosteum* of the labyrinth is, excepting that of outer wall of cochlear canal, very delicate. Consists of several layers of very fine fibrous network, compared by Henle to memb. suprachoroidea. In spaces of network are smooth round or elliptical nuclei, sometimes like epithelium. Also stellate pigment-cells and minute round or ovoid calcareous deposits. Rich supply of vessels. From periosteum of vestibule and semicircular canals fine fibres and many blood-vessels run to outer surface of corresponding parts of membranous labyrinth.

THE MEMBRANOUS LABYRINTH.

The *utricle* [Lat. *utriculus, a little leathern bottle*] :—is a flattened elliptical tube placed upon inner wall of vestibule. Long diameter, $\frac{1}{8}$ in., coresponds to height of vestibule, upper end lying on pyramid, lower end lying opposite ampullar opening of post. vertical semicircular canal. Fastened to recessus ellipticus by fine vascular, nervous and connective-tissue network. Outer wall free and separated from outer wall of vestibule by space filled with endolymph.

Membranoùs semicircular canals of same shape as osseous and open into utricle by five openings, as do osseous into vestibule. At ampullæ, the membranous canals fill the osseous, but in other parts there is considerable space between the two, which is filled by connective tissue, vessels and fluid. Walls of canals and of utricle are clear, transparent and very delicate; about $\frac{1}{1250}$ in. thick, and composed of (1) an outermost layer (*memb. propria*) of reticulate and nuclear fibrous tissue pierced by bloodvessels; (2) a basal membrane; and (3) an innermost layer of pavement epithelium. On inner surface of walls of canals, except on side next to bone, membrane is thrown into numerous elevations. On wall of both utricle and saccule is a more dense point, of circular shape, $\frac{1}{12}$ in. diameter, the *macula acustica*, where twig of auditory nerve reaches it. There is a still more rigid spot, the *crista acustica*, embracing about $\frac{1}{3}$ circumference of ampulla, near its utricular orifice, of yellowish color, about $\frac{1}{50}$ by $\frac{1}{70}$ in. diameter, sometimes surrounded by pigment-line, and receiving also nerve-twigs. Maculæ and cristæ present thickening of memb. propria from mingling of connective tissue and network of nerve-fibres, which enter epithelial cells (?).

The *otolith* of the utricle (*otoconia*, *ear sand*, or *ear crystal*) [Gr. οὖς, *ear*, and λίθος, *stone*,] is a smooth, irregularly demarcated and uneven mass of white powder, loosely held

together by mucoid substance. Powder consists of crystals of carbonate of lime, of varying form and size. Largest about $\frac{1}{2000}$ in. long and $\frac{1}{3000}$ in. broad. How otolith is held to wall of utricle is not settled.

The saccule is a flask-shaped sac, whose body (about $\frac{1}{15}$ in. diameter) lies in recessus sphericus, its blind base directed upward and forward against utricle, the walls of the two sacs being united at a single point. Neck of sac, *canalis reuniens* (about $\frac{1}{35}$ in. long and $\frac{1}{120}$ in. diameter), runs from lower wall down and back, and sinks into upper wall of vestibular end of ductus cochlearis at nearly a right angle, so that a blind sac is formed at junction of the two parts.

The ductus cochlearis begins with above blind sac in vestibule, and passes through whole cochlea to apex, where it ends in another blind sac. Lower end rests in recessus cochlearis, upper end in cupola. Ductus attached on one side to lamina spiralis ossea ; on other, to outer wall of bony cochlear canal. On cross-section is triangular, two walls diverging from edges of lamina spiralis, and third, corresponding to part of cochlear wall, comprised between insertions of the other two. Lower wall, turned toward scala tympani, called *tympanal ;* upper, towards scala vestibuli, called *vestibular*. On border of lamina spiralis ossea is a soft structure—*limbus laminæ spiralis*—which lengthens lamina toward ductus, and is

developed from periosteum of former. Vestibular wall of ductus passes off from upper surface of lamina ossea at inner attachment of limbus, so that latter is included in ductus. Limbus has two lips, an upper, *labium vestibulare*, and a lower, *labium tympanicum*. Furrow between them called *sulcus spiralis internus*. Upper lip projects like a roof over sulcus, and its edge is divided by furrows into oblong sections, which on front view resemble anterior surface of incisor teeth, and are called *auditory teeth*. Furrows filled with rounded (epithelial?) cells, continuous with layer covering memb. vestibularis. Tympanic lip forms floor of sulcus and has two layers which unite in sharp border, continuous with memb. basilaris. *Membrana vestibularis*, or *Reissner's membrane*, forming vestibular wall of ductus, runs from edge of lamina spiralis ossea to outer wall of cochlea. Consists of vascular, connective-tissue basis, covered by endothelium on vestibular side and by epithelium on tympanic side. *Membrana basilaris* [Gr. *βασις*, *base*], forming tympanic wall of ductus, is continuation of labium tympanicum, and increases in width from base to apex of cochlea, as lamina spiralis decreases. Divided into two zones, an inner, *habenula tecta* [Lat. *habenula*, *a little thong*, and *tego*, *to cover*], and an outer, *zona pectinata* [Lat. *pectinatus*, *comb-like*]. Essential layer is structureless membrane. This is thickest at outer zone,

and is there covered, on tympanal surface, with knobby elevations. Embedded in basis substance is a small vein, *vas spirale*, anastomosing through radial branches with vessels of lamina spiralis ossea. On vestibular surface is a layer of very fine radiating fibres, which are most prominent in zona pectinata. Sometimes, fine spiral fibres are found on tympanal surface. Corti's organ lies on inner zone. Outer wall of ductus presents internally the memb. propria of the ductus ; externally. the periosteum ; and, between, a semilunar cushion of connective tissue. Points of insertion of memb. vestibularis and memb. basilaris are prominent, the former called *angulus vestibularis*, the latter, *ligamentum spirale*. A part of the memb. propria just above ligamentum spirale is very vascular and called *stria vascularis*. At lower limit of stria is an elevation, *ligamentum spirale accessorium*, containing a vessel, *vas prominens*. Space between this and insertion of memb. basilaris is called *sulcus spiralis externus*.

Cavity of ductus cochlearis is divided into two parts by a membrane, *Corti's membrane* or *membrana tectoria*, [Lat. *tectorius*, *covering*,] which runs parallel to memb. basilaris from labium vestibulare to outer wall of cochlea. Latter insertion is about midway between memb. basilaris and stria vascularis. Upper space is filled with endolymph. Lower contains terminal auditory apparatus. Tectorian

memb. very delicate but firm. Divided into three zones: Inner one structureless, pierced by numerous openings, and covers labium vestibulare. Middle one densest, and consists of several fine layers of parallel fibres. Outer one consists of a very fine and friable network. Henle thinks membrane is firmly fastened, so that it cannot press closely upon parts beneath. According to Waldeyer, membrane ends near outer wall by thin, free margin, and rests directly on Corti's organ.

Terminal auditory apparatus (Henle) comprises the structures in the lower chamber of the ductus cochlearis. *The auditory rods, pillars or teeth of Corti* [*Corti, Italy, 19th cent.*] are arranged in regular order, somewhat like the keys of a piano. Shaped like Roman S, with slender cylindrical bodies and broad ends, containing granular protoplasm. Two rows, an *inner* (that nearest lamina spiralis) and an *outer*. Rods of each row rest by one end, or *pedestal*, on memb. basilaris. They thence rise quite abruptly, and unite with each other by their other ends, or *heads*, forming an arched roof over inner zone of memb. basilaris, base of arch being about $\frac{1}{250}$ in. broad. Inner rods about $\frac{1}{35000}$ in. broad. Outer rods about $\frac{1}{25000}$ in. diameter, longer than inner, and placed further apart, averaging 7 or 8 to 12 of the latter. Pedestals of inner row lie just outside the perforations in memb. basilaris and the fine ends of the

nerve bundles. Tissue of rods is hard as cartilage (Henle). To heads of rods are fastened plate-like processes—the *head-plates*. Inner rods have two—one on inner and one on outer surface—enclosing a smooth concavity between them, in which heads of outer rods rest, one of latter articulating with two or more of former. Plate on head of each outer rod projects from outer surface, like a phalanx, beyond the joint. Estimated number of pillars : inner, 6,000, outer, 4,500. A perforated membrane, *the lamina reticularis* [Lat. *rete*, *a net*] arises from articulation of rods, and stretches, parallel to memb. basilaris, to outer wall of cochlea. Formed of network of fine hyaline threads, with oblong and round meshes arranged in rows. Tissue, though delicate, is quite firm.

The cells found in ductus cochlearis—*auditory cells*—are nucleated, round, and cylindrical. A layer of them covers sulcus spiralis, Reissner's memb., and outer wall of ductus. Upon inner pillars lies a single row of conical cells with large nuclei. They send processes into row of small cells lying next them toward sulcus—the *granular layer*. The ends turned toward heads of rods bear tufts of stiff, immovable cilia. These cells called *inner hair-cells* (*inner roof-cells* of Henle). Number computed at 3,300. On outer rods lie 3 or 4 rows of double nucleated cells connected by slender processes to memb. basilaris and memb.

reticularis, and bearing also tufts of cilia. Called *outer hair-cells* (*outer roof-cells* of Henle). Number computed at 18,000. Cilia of cells are received by the corresponding rows of openings in the lamina reticularis. Henle describes another layer of cells lying on the memb. basilaris beneath the rods as *floor-cells*. He considers the cells as epithelial or ganglionic. Wâldeyer regards the cells, and also the rods of Corti, as epithelial structures.

Auditory nerve or *portio mollis* [Lat. for *soft part*] of 7th nerve arises by two roots in medulla oblongata. One ganglionic nucleus of origin is in floor of 4th ventricle. The other is in crus cerebelli ad medullam (Stieda). The roots are connected with the gray substance of the cerebellum, with the flocculus, and the gray matter at border of calamus scriptorius (Gray). Nerve winds around restiform body, from which it takes fibres, thence forward across post. border of crus, in company with *portio dura* or facial nerve. The two nerves then pass into the meatus auditorius internus, where some minute filaments connect them together. At bottom of meatus, facial nerve enters Fallopian canal; auditory divides into two branches, *vestibular* and *cochlear*, the former of which here presents ganglionic swelling — *intumescentia ganglioniformis Scarpa*. Cochlear nerve gives off small branch which, at recessus cochlearis, passes

to vestibular end of ductus cochlearis, and through 4th macula cribrosa (p. 181) to partition-wall of utricle and saccule. From trunk of nerve a number of fine branches then arise, which pass directly through *tractus foraminosus* (p. 194) to lamina spiralis of lower wall of cochlea. Remainder of nerve enters modiolus, in which it breaks up into fine anastomotic divisions. Bipolar ganglion-cells are connected with the fibres. Bundles traverse *ganglion spiralis* in canalis ganglioformis (p. 183) at beginning of lamina spiralis, and finally pass into latter. Fibres radiate with numerous anastomoses between the two plates of the lamina spiralis throughout all its turns. *Vestibular branch* after its gangliose expansion divides into three branches: (1.) *Superior*, passes through macula cribrosa superior (p. 181) and ends by three branches to utricle and ampulla of sup. vertical and horizontal semicircular canals. (2.) *Middle*, passes through macula cribrosa media to saccule. (3.) *Inferior*, passes through bony canal of its own to ampulla of inf. vertical semicircular canal.

The terminal nerve-fibres pass from the lamina spiralis, through fine holes in labium tympanicum and in memb. vestibularis, into ductus cochlearis. They run radiate course, passing through granular layer, whence some end in inner hair-cells, and others run between rods of Corti, and across tunnel formed by

them, to end in outer hair-cells. Other nerve (?) fibres run spiral course among granular layer and inner and outer hair-cells, but exact origin and ending is unsettled.

Blood-supply of labyrinth comes through *auditiva interna* artery, a branch from basilar of vertebral. In meatus internus the artery divides into *vestibular* and *cochlear* branches. Former passes in fine twigs through post. wall of vestibule to soft structures of latter and of semicircular canals. Latter sends fine branches through tractus foraminosus into modiolus, and thence between layers of lamina spiralis. Some small branches are said to go to labyrinth from stylo-mastoid.

THE INTERNAL AUDITORY CANAL, or *meatus auditorius internus* [Lat. *equiv*], begins at about the centre of the petrous portion of the temporal bone by a large orifice with smooth, rounded edges, and runs directly outward about $\frac{1}{3}$ in. to end in a blind fossa. Floor of fossa marked by four depressions, which are perforated by fine foramina through which the fibres of the auditory nerve enter the labyrinth. Three of them correspond to the *maculæ cribrosæ* (p. 181). The fourth lies opposite the base of the cochlea, is spiral-shaped with spirally arranged foramina, and is called the *tractus spiralis foraminosus.*

CHAPTER II.

EXAMINATION AND DIAGNOSIS OF AURAL DISEASE.

TESTS OF HEARING:—A watch is held opposite the ear, and the farthest distance at which its tick is heard is noted. It is usual to make this distance the numerator of a fraction, whose denominator is the distance at which the tick is heard by a normal ear. The letters H. D. are used for designating *hearing distance;* R. E. for *right ear*, and L. E. for *left ear*. For example, if a normal ear hears the watch at 40 in., and the right ear of the patient hears it at only 10 in., we write H. D. R. E. $= \frac{10}{40}$. If the watch is heard only when it touches the auricle, H. D. $= \frac{\text{contact}}{40}$ or $\frac{c}{40}$. If when pressed against the ear, H. D. $= \frac{\text{pressed}}{40}$ or $\frac{P}{40}$. If not heard at all, H. D. $= \frac{0}{40}$. Sometimes the watch is only heard when pressed against the mastoid process, H. D. $= \frac{\text{mastoid}}{40}$. The clicking noise made by rubbing the edges of the finger-nails together

is sometimes a convenient substitute for the watch-tick.

Another test of hearing-power is *the voice.* Stand behind the patient, and find at what distance he can hear ordinary or loud conversation. There is often a curious disproportion between the two tests: a patient who scarcely hears a watch at all may hear conversation at twenty feet. The voice-test, therefore, gives the best idea of the *practical* hearing-power present.

The tuning-fork is used to determine whether a lesion of the auditory nerve exists. It is made to vibrate, and its handle is then placed upon patient's forehead or (preferably) his closed teeth. If disease is confined to external or middle ear, sound of fork is heard most distinctly in ear most affected. If nerve is affected, fork is heard better in better ear. In mixed cases test is less useful. A source of error in using this test is that patients are apt to say they hear the fork better in the better ear because they think they *ought* to do so. Large forks of the note C are those generally used.

Condition of nasal and pharyngeal mucous membrane should always be examined. Rhinoscopy and laryngoscopy are of great assistance.

Present condition of general health and inquiries as to past illnesses are very important.

THE AURICLE is easily examined.

For examining EXT. AUDITORY CANAL and *membrana tympani* an aural speculum and mirror are necessary. End of speculum is inserted about ¼ in. into meatus, and held between thumb and forefinger of one hand; at the same time the upper edge of the auricle is held between same forefinger and the middle finger. In this way the auricle can be pulled upward and backward, which obliterates curves of canal, and allows clear view to bottom of it. Parts are illuminated by the *otoscope*—a round, concave mirror about 3 in. diameter, with central perforation—which is held close before the observer's eye at a distance of 6-10 in. from the patient. Either daylight or artificial light may be used; former is simpler, and generally answers every purpose. When both hands are required for examination or for making applications, mirror is held on forehead by an elastic band passing around head.

THE EUSTACHIAN CATHETER AND POLITZER'S METHOD are used to introduce air into the middle ear through the Eustachian tube. Their diagnostic use is to show whether tubes are pervious, and whether predominating elements of disease are such (catarrhal) as can be relieved by inflation. If so, patient will feel the puff of air enter his ear, drumhead will probably be pushed outward and

congested, and hearing will be improved. To introduce the catheter:

(1.) Have instrument warm and moist.

(2.) Let patient hold his head in natural position and have him blow his nose to moisten nostril.

(3.) Place forefinger of one hand on patient's upper lip and stretch it downward.

(4.) Hold catheter lightly with the other hand near its large end and in vertical position, with the ring on its handle pointing toward median line. Then introduce its curved beak gently into nostril corresponding to ear under examination, and as soon as it has fairly entered nose raise handle into horizontal position and push catheter very gently back, with its beak hugging floor of nostril, until it is felt to strike the hard posterior wall of the pharynx.

(5.) Withdraw catheter about $\frac{1}{4}$ in. rotating it about one-quarter on its axis so that ring on its handle points toward ext. auditory meatus, when point will generally fall opposite orifice of tube. If catheter is in proper position, it will not be disturbed by patient's talking or swallowing. It may be steadied by resting fingers against patient's nose, while air is forced through it from an ordinary air-bag. When tubes do not open freely, patient may be made to swallow a little water at moment of forcing air through catheter. Having

patient say *hoc* will often answer the same purpose. Difficulties in introducing the catheter are generally due to its being held in wrong position, so that it enters middle meatus of nose; and to patient's spasmodically contracting his facial muscles so as to prevent the necessary relaxation of the parts. Sometimes the manipulation is made difficult or impossible by a very crooked or occluded nostril.

POLITZER'S METHOD [*Adam Politzer*, *Vienna*, 19*th cent.*] of inflating the middle ear consists in forcing air through the nostril and Eustachian tube during act of swallowing, which opens tube and brings uvula against pharyngeal wall, shutting off upper from lower pharyngeal space. Patient takes a little water in his mouth and holds it until a given signal. Nozzle of an air-bag is then inserted into his nose and both nostrils tightly squeezed together around it. Signal is then given, and, as patient swallows the water, air-bag is compressed and air forced in. When it is very difficult to make air enter the ear, it may often be done easily by mingling a little chloroform vapor with it. This is done by putting two or three drops of chloroform on the little sponge contained in the bulb of the improved Politzer's apparatus now generally used. For children, Politzer's method is best used by means of a simple piece of rubber tubing, through which air is blown directly from surgeon's lungs. If child is too young to swallow water at a given

signal, it will usually cry during the operation, and that opens the tube just as well.

VALSALVA'S METHOD, or the VALSALVIAN EXPERIMENT [*Valsalva, Italy, 17th cent.*] consists in taking a deep inspiration, and then forcing the air outward so as to distend the cheeks and inflate the ears, while the mouth and nostrils are kept tightly closed. Its frequent use congests the ears and relaxes the drum-head; and, being inferior to the other methods, it should not be advised.

Some pass slender *bougies* through the catheter to examine for strictures of the tube. Their use is dangerous and requires great caution.

THERAPEUTICS AND SURGERY OF THE EAR.

SYRINGING THE EAR: There are needed a syringe (holding 4 to 6 oz.) with a bulbous nozzle, a bowl to hold the water, and a lighter one (such as a finger-bowl) to catch it. Patient, being seated, holds the small bowl under the auricle and pressed firmly against the cheek, to prevent the water from running down his neck. Operator should straighten canal by pulling auricle up and back with one hand, and, placing nozzle of syringe well into meatus, should gently force the stream down to the

bottom of it. As a rule, only simple water should be used, and as warm as can be borne comfortably.

THE AURAL DOUCHE: Is used where *a steady flow* of warm water is required,—as in acute inflammations. Douche consists of a cup to hold the water, with a piece of rubber-tubing attached. Cup is placed above the head, so that the water runs through the tube and into the ear from its own weight. Force of stream can be regulated by height of cup. Ordinary *fountain syringe* makes a very convenient douche.

Where syringing causes pain or vertigo, water may be dropped into the ear from a sponge: or a camel's-hair brush dipped in warm water may be used.

THE COTTON-HOLDER:—Is simply a slender, steel probe, around whose end a little cotton can be wound. Used to cleanse and dry the deep parts of ear and to make applications to them. Should only be used under good illumination from otoscope. Cotton should be very soft and clean.

LEECHES: In inflammations of external auditory canal or middle ear, should be applied at base of *tragus*, on front wall of canal (*not* on mastoid process), for reason that at this point vessels which supply diseased parts are most conveniently and surely reached. Cotton should be placed in meatus to keep leech from crawling in.

By using leech-glass and scratching tragus to draw a little blood, the leech can be applied to the exact spot desired. After-bleeding should be encouraged for an hour or more, after which it can be checked with styptic-cotton, &c.

Blisters behind the Ear: Usually of very little use in chronic inflammation; and in acute attacks, where prompt measures are needed, they merely add to patient's discomfort.

Poultices: Injurious as a rule. In acute inflammations, tend to make tissue œdematous and to favor its breaking down. If ever needed to quiet pain, should be of conical shape, small enough to be pushed into meatus, and only applied for a short time.

Medicated Solutions to be dropped into the ear should always be warmed. Easily done by holding them in spoon or test-tube over a flame.

Inflation of Middle Ear: (Vide p. 199.)

Paracentesis of Membrana Tympani: Often performed in acute inflammation of middle ear. As large a speculum as possible is used; and, while ear is well illuminated by forehead-mirror, paracentesis-needle is passed along floor of meatus until drum-head is reached. Membrane can then be pierced at any point desired. After incision it is usual to inflate ear by Politzer's or Valsalvian method. This opens the wound and tends to

force out any matter which may lie in the tympanic cavity. Paracentesis is also performed for chronic cases of non-suppurative inflammation, its principal use being to facilitate medication of middle ear.

DIVISION OF TENDON OF TENSOR TYMPANI MUSCLE at its insertion into the malleus is sometimes done, where muscle's contraction appears to cause injurious pressure on fenestra ovalis. Tenotome is passed through ant. segment of drum-head, a little below short process of malleus, and point pushed around behind malleus so as to reach tendon.

DIVISION OF ADHESIONS between memb. tympani and promontory may be successfully done by a knife devised for the purpose.

INSERTION OF AN EYELET INTO MEMB. TYMPANI, to preserve a permanent opening, is sometimes done. Operation difficult and not free from danger. [All these latter operations are performed in desperate chronic cases, and results thus far have been chiefly negative.]

TREPHINING OF MASTOID PROCESS:—(Vide. p. 227.)

HEARING-TRUMPETS:—Thus far there are no aids for conducting sound to the ears of persons incurably deaf more efficient than the ordinary metallic or flexible tubes known as hearing-trumpets.

CHAPTER III.

DISEASES OF THE EAR.

AURICLE.

1. *Injuries.*
2. *Eczema.*
3. *Tumors.*
4. *Malignant Disease.*
5. *Malformations.*

INJURIES : are of various kinds, and require same treatment as in other parts.

ECZEMA : is quite common, and generally associated with eczema of external auditory canal (vide p. 210). Presents same appearances as elsewhere and requires same treatment.

TUMORS :—comprise (a) *Fibro-cartilaginous;* simple hypertrophies ; most frequent among negroes ; result often from irritation of piercing ears for earrings, and where brass earrings are worn ; may be removed by V-shaped incision, edges of which are afterwards united by sutures. (b) *Sebaceous;* may be enucleated. (c) *Erectile;* best treated by galvano-caustic. (d) *Othæmatoma* or *vascular tumor;* idiopathic and traumatic. In former, ear becomes red, swollen and hot, and then effusion blood occurs, mostly in concha, obliterating

folds of auricle, and causing painful, roundish tumor, of variable size, in which fluctuation may be found ; effusion may be absorbed or rupture or suppurate ; etiology supposed to be cerebral congestion and centripetal irritation from the emotions ; most common among the insane ; some advise non-interference, others opening and evacuating sac and use of pressure-bandage ; after recovery great deformity is apt to result. Traumatic form is simple extravasation from vessels ruptured by violence, and is not apt to leave deformity.

MALIGNANT DISEASE is very rare ; amputation of auricle is the proper remedy.

MALFORMATIONS : may be congenital or result from ill treatment (such as allowing hat to press against auricle, etc.), or from disease. Auricle may be congenitally absent, or rudimentary, generally with same defect of deeper parts. Supernumerary auricles have been observed.

DEPOSITS OF URATE OF SODA are often seen on the auricles of gouty subjects, especially on the helix : sometimes cause considerable pain.

DIFFUSE INFLAMMATION and ABSCESSES of the auricle, from whatever cause, require careful attention, as they tend to produce great deformity.

External Auditory Canal.

1. *Foreign Bodies.*
2. *Inspissated Cerumen.*
3. *Diffuse Inflammation.*
4. *Circumscribed Inflammation.*
5. *Eczema.*
6. *Vegetable Fungous Growths.*
7. *Polypi.*
8. *Syphilitic Ulcers and Condylomata.*
9. *Exostoses and Hyperostoses.*

Foreign Bodies: Include insects and their larvæ, and such articles as beads, buttons, peas, beans, etc., which are thrust into ear, especially by children. Insects sometimes fly into ear; cause agonizing pain. Syringing with warm water usually brings them out at once. They are readily attracted by the odor of a suppurating ear to deposit their larvæ upon the pus within it; larvæ may cause pain, or only discomfort, by their wriggling motions. Examination of an ear so affected shows small, white, worm-like animals moving rapidly about; they are provided with hooks by which they cling to the tissue. Cannot generally be dislodged by syringing, unless some parasiticide has first been used. Labarraque's sol., chloroform vapor, carbolic acid sol., etc., have been used for this purpose; sometimes forceps are necessary. Beads, buttons, etc., are chiefly dangerous

through indiscreet efforts to remove them ; through such attempts, the ear, and even the life of the patient has been destroyed. Beans, peas, etc., are troublesome, because they swell after being in canal for some time. In treating these cases, first thing to do is to examine ear with otoscope ; never try to remove a foreign body which you cannot *see*. In ordinary cases, simple syringing will suffice. If body is impacted, and there is inflammation and swelling about it, better to wait until latter subside. If instruments become necessary, patient should be etherized and body dislodged, if possible, by forceps or probe, and then removed by syringe. Value of patient and gentle manipulation cannot be overrated. If foreign body is causing no bad results, there need be no haste about its removal. If instruments really become necessary, they should only be used by a practised hand. Foreign bodies sometimes penetrate into the middle ear, but require no different treatment to that given above.

INSPISSATED CERUMEN, or hardened wax, is quite often found in auditory canal. In majority of cases, probably secondary to some other affection of ear, and should be so considered when complete relief of symptoms does not follow its removal. Wax is not removed by motions of jaw, as it normally is, but collects in canal, its watery parts evaporate, and a brown or black mass is left, some-

times as hard as stone. *Symptoms* are deafness, tinnitus [Lat. for *ringing*], sense of fullness, vertigo, and pain—two latter being rather infrequent; deafness usually sudden, because it does not occur until *impaction* takes place, although there may be a great deal of wax present; impaction may result from any sudden jolt, etc. Wax easily seen with otoscope as dark mass, filling canal. Simple syringing with warm water best method of removing wax, and usually sufficient. Sometimes, where wax is very hard, a solvent, such as sol. sodæ bicarb., (grs. x. to ℥ i.) may be dropped into the ear several times for a day before the syringing is begun. Several sittings may be needed to remove the wax, and they are preferable to doing too much at once. Probe may be necessary to loosen mass and break up its hardened surface, so that syringing may be effectual. Instruments should be avoided, however, if possible. All the wax should be removed, as even a small piece left upon drum-head will keep up the unpleasant symptoms. Where hearing is normal after removing wax, a little cotton should be kept in ear for a few days, otherwise sounds will be unpleasantly acute, and shock of them may injure the ear. Where hearing is not normal, after the wax has been removed, inflation may improve it.

DIFFUSE INFLAMMATION is quite rare.

Caused by local irritation, such as ear-picks, dropping of oils into ear, etc., and, rarely, by exposure to cold. Symptoms are itching, followed by pain, sense of fulness, and, perhaps, some deafness. Canal and memb. tympani red and swollen, and epidermis and integument may suppurate. Where skin is closely adherent to bone, pain is intense and disease is essentially a periostitis. Treatment in acute stage comprises leeches, incisions, and warm douche; and, if these fail, poultices. If suppuration is established, ear should be thoroughly cleansed every day by syringe, and astringents applied. Solution of alum or zinc (gr. 1–4 to ℥ i.) may be dropped into ear by patient after syringing. Surgeon should cleanse the ear himself 3–4 times a week, and pencil a strong sol. nitrate silver over affected part.

CIRCUMSCRIBED INFLAMMATION or FURUNCLE is a symptom of a wrong state of the system. Apt to occur in anæmic persons, and to be recurrent. Very painful, and may cause deafness by filling up canal. Does not usually cause tinnitus. Proper treatment is to make an incision as soon as possible, whether pus has formed or not, and then to use warm douche freely. Probe is useful to find the most tender point where furuncle is not very marked. Incision is best made with a sharp-pointed bistoury, and should be a deep and free one. Leeches are not of much service.

Small cotton plug, saturated with glycerine, sometimes useful to quiet pain.

ECZEMA : generally associated with eczema of auricle. Swelling of canal causes fulness and tinnitus, with deafness. Disease is rarely brought to notice until it has become chronic. In treatment, first requisite is thorough removal of exuded matters every day, and this is best done by the surgeon himself. Warm douche and cotton-holder are best means. After cleansing, an astringent should be applied, a liquid one being best, as it does not clog up the canal. Frequent use of the warm douche by the patient is useful for keeping the canal clear and to allay pain and itching.

VEGETABLE FUNGI ; sometimes germinated in auditory canal, and cause or aggravate inflammations of the part. Most commonly secondary to eczema. Symptoms of *otitis parasitica* are tinnitus, fulness, deafness, dull pain, vertigo, whitish or blackish flakes adhering to walls of canal and outer surface membrana tympani, and blocking up passage. Latter require forceps for their removal, and tissue beneath them is found red and tender. Growth may reappear in a few hours. Varieties of parasites are :

1. *Aspergillus.* $\begin{cases} \textit{flavus.} \\ \textit{glaucus.} \\ \textit{nigricans.} \end{cases}$

2. *Penicillium glaucum.*
3. *Graphium pencilloides.*
4. *Tricothecium roseum.*

They can only be seen by the microscope. *Treatment* consists in keeping canal free from fungus and subduing inflammation. Many parasiticides are recommended, but the warm douche thoroughly used is as good as any. Inflammation of canal is treated as usual.

POLYPI : are result of a prolonged or violent acute suppuration, or one that has been augmented by poultices so that integument has been destroyed by ulcerative process. Usually associated with polypi of middle ear and require same treatment (vide p. 224.)

SYPHILITIC ULCERS and CONDYLOMATA ; very rare. Require local cleanliness and the proper internal remedies for syphilis.

EXOSTOSES and HYPEROSTOSES, or bony growths. Sometimes occur in osseous part of auditory canal. Most frequently come from chronic suppuration of the middle ear, extending its irritation to the canal, and will therefore be considered under that section (vide p. 225). May be congenital or occur in some special diathesis. If canal is occluded by growth, an operation for opening a passage through it (such as that of boring a hole with a rat-tail file or a dentist's drill) must be performed.

INJURIES OF MEMBRANA TYMPANI : Subject to injuries from concussions, from effects of condensed air, from foreign bodies, instruments, etc. Membrane has been *ruptured* from artillery explosions ; from exposure to condensed air, as in caissons used in building bridge-piers ; from blows upon side of head ; from waves striking side of head in sea-bathing ; from violent vomiting, coughing, blowing of nose ; from hair-pins, blades of straw, etc., thrust into ear ; from use of instruments, etc. Where there is disease of ear, and collection of mucus in tympanum and Eustachian tube, drum-head is much more liable to rupture from all the non-traumatic causes than where parts are healthy. Rupture of drum-head in suppuration of the middle ear belongs under that section. To determine the nature of a rupture it should be seen soon, before suppuration has had a chance to occur around it. Traumatic ruptures are apt to heal promptly, without suppuration, and to leave hearing intact. Those from concussion are serious, as deeper parts are generally injured at the same time. *Treatment:* Above all, ear should not be disturbed by syringing or otherwise immediately after the injury. If inflammation and suppuration appear, they should be treated as in acute inflammation

of the middle ear. Meanwhile, the ear should be protected by a bit of cotton placed in meatus, and patient kept under careful but not meddlesome observation.

MYRINGITIS [Lat. *myringa*] or INFLAMMATION OF DRUM-HEAD, is only part of an inflammation of adjacent regions. The anatomical structure of a membrane which has no independent nutrition, which has but one layer of tissue peculiar to itself (and that in its centre), but which is a direct continuation of neighboring parts, rather precludes the idea of its being primarily diseased.

FRACTURE OF THE HANDLE OF THE MALLEUS is very rare, only three or four cases having been reported. The diagnosis in these cases was based upon the peculiar, irregular appearance of the bone.

The principal affections of the middle ear are :

1. *Acute Catarrhal Inflammation.*
2. *Subacute Catarrhal Inflammation.*
3. *Chronic Non-Suppurative Inflammation.*
   (a.) *Catarrhal.*
   (b.) *Proliferous.*
4. *Acute Suppurative Inflammation.*
5. *Chronic Suppurative Inflammation.*
6. *Consequences of Chronic Suppuration.*
   (a.) *Polypi.*
   (b.) *Exostoses.*
   (c.) *Mastoid disease.*

(d.) *Caries and Necrosis of temporal bone.*
(e.) *Cerebral abscess.*
(f.) *Pyæmia.*
(g.) *Paralysis.*

ACUTE CATARRH of the middle ear is quite common. Has many causes, such as exposure to cold and wet; allowing cold water to run into ear; "colds in the head;" constitutional diseases, such as scarlet-fever, measles, small-pox, pneumonia, syphilis; use of "nasal douche," etc. Danger from latter instrument probably due to entrance of large quantities of water through Eustachian tube into tympanum. Acute catarrh generally starts from faucial end of Eustachian tube, but may sometimes extend from ext. auditory canal. *Symptoms* are pain; sense of fulness; tinnitus; impairment of hearing; injection, swelling, and bulging outward of memb. tympani; catarrh of pharynx and Eustachian tube; fever, and, rarely, delirium.

The pain is usually intense. The familiar "earache" is identical with acute catarrh. In children too young to speak, it may be difficult to locate the pain. Pressure against the ear to see if the child winces, and dropping warm water (or even breathing) into the ear to see if it quiets the pain, are useful diagnostic tests. Sensations of *fulness* may precede pain or follow it. Tinnitus generally assumes form of a *beating* or *puffing* in the ear, and is dis-

tressing. Deafness may not be marked in stage of pain; indeed, hearing sometimes seems more acute than normal. Redness of memb. tympani may be confined to periphery and along malleus-handle, or be intense over whole membrane, effacing all its normal appearances. Bulging outward of the membrane may often be seen after the first 48 hours of the attack, generally in posterior part, and in Shrapnell's membrane. Spontaneous perforation is then apt to follow. Fever, and even delirium, are sometimes present.

Treatment should be antiphlogistic and prompt. First remedy in efficiency is local blood-letting by one to four leeches to the tragus (p. 201). Next is warm water poured into the ear by the douche so as to give it a continuous bath. Douche may be used for several minutes every half-hour. Breathing into the ear, steaming it, and blowing in of tobacco-smoke are sometimes useful to quiet the pain. Poultices should only be used when other measures fail, as they are dangerous to the integrity of the drum-head. Dropping of oils, molasses, etc., into the ear is useless, and only clogs up the canal. A little laudanum may be added to the warm water, if desired, and opium may be given internally. If perforation of memb. tympani is threatened, a paracentesis should be performed; or it may be done to relieve the pain where other means have failed, even when there is no bulging

(p. 202). If the mastoid region becomes involved, an incision should be promptly made down to the bone (p. 226). The catheter and Politzer's method are advisable as soon as the acute symptoms have subsided.

Such prompt treatment generally results in a perfect cure, saving the patient from chronic otitis and its bad consequences. If suppuration occurs, it is usually tractable (p. 221).

Several cases of acute catarrh have occurred in which the course was very rapid, ending in perforation without suppuration, but with abundant hemorrhage through the drum-head. In other cases of acute catarrh, where a paracentesis has been done, only blood has escaped from the tympanum. The name given to such cases is *otitis media hemorrhagica*. [Hemorrhage into the middle ear may also occur from atheromatous vessels, as in kidney disease.]

SUBACUTE CATARRH :—Common in children and young persons. Distinguished from acute catarrh chiefly by its milder course and by the absence of severe pain. Patient is subject to seasons of marked deafness, fulness and tinnitus ; memb. tympani is pinkish with small light spot, and pharynx is catarrhal. Pathological changes are probably plugging of the Eustachian tube and tympanum by mucus, without structural changes. *Treatment :* It will generally be found that patient is badly managed, and needs proper hygienic

care; such as regulation of diet, attention to skin, proper exercise, etc. Tonics and attention to pharynx are important. The use of the catheter (except in children) and Politzer's method generally restore the hearing—in some cases almost immediately.

The non-suppurative inflammations are described separately for convenience, but it must be remembered that in practice the line of separation between them is not always well marked :—

CHRONIC CATARRH OF THE MIDDLE EAR: Forms a large proportion of the cases presenting themselves for treatment. It is either a consequence of acute catarrhs, or supervenes upon chronic catarrh of the throat, especially in constitutions enfeebled by disease or bad hygiene. Patient has the usual symptoms of chronic naso-pharyngeal catarrh. In addition, he has occasional sounds in his ear like crackling of air-bubbles ; sense of fulness ; tinnitus ; deafness ; sometimes vertigo. Tinnitus is very annoying, causes great depression, sometimes resulting in suicide. Noises variously described as buzzing of insects, rushing of water, ringing of bells, etc., etc. There are also changes in the memb. tympani, and imperfect action and changes in structure of Eustachian tube. Appearances of drum-head are valuable in connection with other signs, but not always diagnostic, as many of them may also

be seen in normal ears. A sinking inward of the drum-head rarely occurs without deafness. It is shown by unusual prominence of short process of malleus with altered position of handle; by diminution, irregularity or absence of the light spot; and by a general collapsed appearance of the membrane difficult to describe. There may be a loss of the normal lustre of the membrane, with opacities and calcareous deposits in it. It may have lost its natural mobility from adhesions, or be preternaturally mobile. This may be tested while patient performs Valsalva's experiment, or by Siegle's otoscope. Changes in pharynx and Eustachian tube usually marked. Former presents familiar appearances of chronic catarrh. Often it is studded by small, round elevations, constituting *pharyngitis granulosa*. Rhinoscope shows similar conditions about mouth of Eustachian tube. Catheter is valuable as a *sound* for determining the condition of the nasal mucous membrane as to swelling, polypi, etc., and for testing permeability of Eustachian tube. Pathological changes in chronic aural catarrh, as shown by sections by Toynbee, Tröltsch, and others, are collections of mucus distending tympanum; thickened mucous membrane; filling of cavity by lymph.

Treatment.—All needed measures for improving general health. Everything that renders patient more vigorous and less likely

to take cold will assist in relieving chronic aural catarrh. Attention to skin, daily sponge bathing and frictions, Turkish baths, etc., are very useful. Treatment of pharynx and nose very necessary. Injections of the naso-pharyngeal space by a long syringe made for the purpose, are useful to dislodge collections of matter, if for nothing else. Various solutions are used in the syringe, of which those of salt and chlorate of potash are most common. Nasal douche dangerous, as it has often caused acute inflammation of middle ear, even when all precautions had been observed in its use. Better to wash out nostrils with Davidson's syringe by *gentle and intermittent* current. Same solutions are used as in post. nares syringe. The applications to be made to the nasal and pharyngeal mucous membrane will, of course, vary with different practitioners. A gargle is a matter of individual choice. Saturated sol. chlorate of potash as good as any for ordinary purposes. Tröltsch's method of gargling is useful as *gymnastic exercise* for muscles of tube, aside from its effect on mucous membrane :—The gargle is held in back part of mouth, the head thrown well back, and the nostrils closed with the fingers ; swallowing motions are then performed without actually swallowing the solution. Eustachian catheter is used for treating tube and tympanic cavity. Simple air blown through it is most universally useful. Steam,

weak solutions iodine, nitrate silver, zinc., etc., are also used. Inflation of middle ear by Politzer's method should be done every day or two. Most effectual when used after catheter. Whenever attacks of congestion or pain occur in course of disease, leeches, warm douche, etc., should be tried (vide p. 215).

Chronic Proliferous Inflammation:—In this form, the symptoms, except loss of hearing and tinnitus, are less positive than in catarrhal form. There is no pharyngitis, and patient's history does not include infantile earaches, coryza, frequent colds, etc. It is found that disease has begun and advanced insidiously, that it has got under full headway and essentially impaired hearing before patient has noticed it. There may be no sign of catarrh, no closure of Eustachian tubes, nothing pointing to an excess of secretion in pharynx, tubes or tympanum, but rather to an opposite state of affairs. There are apt to be adhesions in tympanic cavity with a sunken and immovable drum-head. Often no cause can be discovered. Sometimes there has been a catarrhal inflammation which has long since passed away. In certain cases, the disease seems to have some connection with pregnancy. Pathological changes found include : adhesions in tympanic cavity, anchylosis of ossicles, atrophy and fatty degeneration of tensor tympani, obstruction of tube

and tympanum by dense fibrous tissue, hypertrophy of bone, etc.

Treatment: like that of catarrhal form, excepting that pharynx does not usually need attention.

In many of the cases of non-suppurative inflammation, a *cure* is out of the question, and the best that can be hoped for is to alleviate the condition or keep it stationary. Hygienic treatment should be kept up during patient's life. Local treatment, if it does any good, may be given for from 1—2 months, twice a year. Some cases progress in spite of every remedy. For inveterate cases which resist all ordinary treatment, such operations as exhaustion of air from drumhead, maintaining permanent opening in it, and division of tensor tympani are sometimes performed. They are only to be undertaken by a skilled surgeon, and indications for them will be found in larger text-books. As a rule, they are not productive of much benefit.

ACUTE SUPPURATION OF MIDDLE EAR: usually a direct result of acute catarrh, and preceded by its violent and painful symptoms (p. 214). In many cases, however, latter process is unobserved and discharge of pus is first thing noticed. In cases occurring from scarlet fever, measles, etc., catarrhal stage apt to be overlooked because of grave symptoms of the general disease. Causes are same as those of acute catarrh, exposure to cold being most

common one. When drum-head bursts, pain usually subsides. Sometimes pus escapes through Eustachian tube leaving drum-head sound. Occasionally, suppuration extends to brain through thin tympanic wall, or produces pyæmia by entering jugular vein.

Treatment: In early stages, leeches; and if membrane seems about to break, paracentesis should be done in most bulging part. (p. 202). If mastoid is red, swollen and tender, an incision should be promptly made down to bone. (p. 226). Ear should be douched frequently with warm water. If membrane has already ruptured, ear should be cleansed of pus at least twice a day by syringing, after which a weak astringent, such as sol. zinci sulph. (gr. ii. to ℥ i.) should be dropped in (p.202). This may be done by patient himself. Ear should be cleaned and astringent applied by surgeon every other day, if possible. Politzer's method may be used gently every day or so, to blow secretions from tympanum and prevent formation of adhesions. Under this plan, case usually progresses well, membrane heals and good hearing is restored.

Chronic Suppuration of the Middle Ear: commonly called *otorrhœa*, or "running from the ear." Often mistaken for chronic suppuration of ext. auditory canal, which is very rare—a mistake which need never occur if otoscope is used. Chief symptom is puru-

lent discharge. This may be profuse or scanty, or only periodic. In latter case, mass of dried pus may be found in canal and tympanum when ear is examined. Drum-head may be swept away and ossicles also ; or there may be a rim of it left with one or more of the ossicles in place or dislocated ; or there may be one or more cleanly-cut holes in it, with ossicles in position. Sometimes, perforation is very small and only detected by having air blown through it from Eustachian tube, when the "perforation-whistle" will be heard, or a drop of pus blown out through it. *Pulsation* at bottom of canal is suspicious but not pathognomonic of perforation. Depends on layer of fluid in contact with beating blood-vessel. Pharynx and Eustachian tube usually in catarrhal state, and general health below normal. Degree of deafness variable, depending as it does on many factors. Course of disease tedious and requires very patient treatment. In some cases, suppuration never is permanently subdued. Anatomical relations of tympanic cavity show the danger of allowing disease to proceed unchecked. (p. 224).

Treatment :—First requisite is *cleanliness*. Ear should be syringed once or twice a day. (p.200.) Should be cleaned by surgeon himself as often as he may think best. Politzer's method is an aid in blowing secretions out of tympanic cavity and breaking up adhesions.

After cleansing, some astringent or caustic should be applied. If perforation is small, an astringent solution may be dropped into ear and allowed to remain 5 or 10 minutes (p. 202). If drum-head is gone, solution may be swabbed over the exposed surface by a cotton-holder. Various solutions are used :—Zinci sulph. gr. 1–5 to ℥ i. ; argenti nitrat. gr. 10–480 to ℥ i. ; cupri sulph. gr. 1–5 to ℥ i. ; alum sulph. gr. 1–5 to ℥ i., &c. Various powders are also blown into the ear—such as alum, iodoform, bismuth, salicylic acid, &c. Application may be changed now and then with advantage. After irritation and suppuration have subsided, hearing may sometimes be improved by insertion of an artificial drum-head. Latter is only of service where drum-head is partly or wholly destroyed, and where deafness is marked. It must be used carefully, and removed at once if it causes irritation.

CONSEQUENCES OF CHRONIC SUPPURATION.

Polypi :—usually consist of loose connective tissue, cells, and blood-vessels, and are analogous to the well-known exuberant granulations. Generally spring from tympanic cavity, but sometimes from auditory canal (p. 211). Most common cause is a long-continued suppuration of middle ear. Best method of removing aural polypus is by Wilde's polypus-snare or by scissors. Forceps are more dan-

gerous, especially in unskilful hands. The manipulations are performed through a speculum under illumination from the otoscope. Granulations attached by a broad base, which are hard to remove by snare, may be frequently punctured with needle and then touched with nitric acid or some other strong caustic. The removal of a polypus usually improves the hearing. [Malignant growths sometimes occur in ear which assume form of polypi, and may be mistaken for them.]

Exostoses and hyperostoses, or bony growths:—are both congenital and acquired. The congenital ones usually cause no inconvenience and require no treatment. The acquired have an inflammatory origin and most commonly result from chronic suppuration of middle ear. The local irritation causes first a periostitis, and, secondarily, an enlargement of bone. Sometimes occur in connection with a special diathesis, such as the gouty, rheumatic, syphilitic, &c. May grow so large as to block up canal and cause fatal retention of pus. *Treatment* should be directed to cause. Ear should be kept scrupulously clean, to prevent retention of pus. Iodine may be painted over tumor. If occlusion occurs, a passage must be opened for exit of pus by an operation. The operation of boring a hole through the tumor with a rat-tail file is called *Bonnafont's* (p. 211).

Mastoid disease:—includes periostitis,

caries and chronic suppuration. Mastoid periostitis often arises in suppuration of middle ear. Is marked by pain, redness, swelling and tenderness of mastoid region. If not relieved may extend to brain through some of the connecting foramina. An incision should be promptly made over the mastoid process, parallel to attachment of auricle and reaching down to the bone. It should not be a mere puncture, but a cut at least three-quarters of an inch long. In early stages, pus will not be found, but bleeding and relief of tension from incision will do good. Poultice should be applied and opening maintained by tent for some time. In children, and sometimes in adults, there is a redness and œdematous swelling of mastoid which does not need such a prompt incision, and which may recover without it. It differs from a true periostitis by the absence of the great *tenderness* of the latter affection.

Caries and suppuration of mastoid process is an extension of the inflammation last described. Bony partitions between the cells become dissolved and break down into a granular detritus. Symptoms do not differ much from those of periostitis, and diagnosis may be difficult. Any persistent, deep-seated pain in mastoid region is suspicious. A fistulous connection with auditory canal sometimes exists. First remedy is incision, like that for periostitis. If fistula is found in bone it should

be enlarged to give exit to pus. If there is no fistula mastoid must be trephined, if there is suspicion of caries or retained pus. The periosteum is first dissected up, and a small trephine worked *carefully* in a direction inward, forward and upward. Cell-structure is usually reached at depth of $\frac{1}{6}$–$\frac{1}{4}$ inch. Wound should be dressed from bottom with lint and kept open for some time.

Caries and *Necrosis of Temporal Bone:* may occur from chronic suppuration of middle ear, and maintain the discharge of pus in spite of all efforts to stop it. Spot of diseased bone may be very minute or quite extensive. Use of probe for diagnosis must be very cautious. From relations of tympanic cavity, caries of its walls is very dangerous. In some cases, diseased bone is thrown off and parts heal. Nearly whole petrous bone has been exfoliated in this manner. Fatal hemorrhage has occurred from caries of walls of carotid canal, lateral sinus and jugular vein.

Cerebral Abscess: Suppuration of middle ear is most common, single cause of cerebral abscess—especially where there is not a free exit for pus. Symptoms of extension to brain sometimes insidious. May be a chill or convulsion, nausea and vomiting. Or, increased pain, followed quickly by paralysis, coma, and death. Or death may occur suddenly without being preceded by brain symptoms.

Pyæmia or Metastatic Abscesses may occur

from aural disease by entrance of pus into circulation through mastoid veins or lateral sinus. Several such cases have been reported, some of which recovered.

Paralysis of 7th nerve as it passes through tympanic cavity in Fallopian canal may result from suppuration and caries of middle ear. May be temporary, from pressure on nerve; or permanent, from destruction of it.

INTERNAL EAR.

NERVOUS DEAFNESS is an affection of the auditory nerve or labyrinth, or of both. Primary nervous deafness is the rarest of all aural diseases. Secondary disease of labyrinth, extending from middle ear, is probably quite frequent. Primary disease may result from injury, such as fracture of petrous bone; from hemorrhage or serous effusion into labyrinth through diseased blood-vessels; from inflammation of membranous labyrinth (?); from concussions of nerve, as in boiler-shops, cannonading, etc.; from large doses of quinine, acting by congesting nerve (?); from meningitis and cerebro-spinal meningitis, by direct extension of inflammation; from syphilis, perhaps by periostitis and gummata of labyrinth; from fever and the exanthemata; from aneurism of basilar artery, cerebral tumors, etc.

Symptoms: only pathognomonic one is *absolute deafness.* Staggering gait or loss of equilibrium is also a symptom of nerve-deafness. Many cases in which latter symptom was marked have been wrongly classified as *Mènière's disease*, after Dr. P. Mènière, of Paris, who recorded several such cases. Only autopsy he made showed disease *confined to semicircular canals*, but the case was not a fair type of the others. Another point is that nerve-deafness usually occurs *suddenly.* Such symptoms as *partial* deafness, tinnitus, vertigo, nausea and vomiting, occur also in affections of the middle ear,—but nausea and vomiting are rare unless labyrinth is involved. In disease of nerve, tuning-fork is heard better in better ear (p. 196), and stopping meatus with finger does not intensify sound of fork, as it does if disease is confined to middle ear. There are no appearances of membrana tympani that give evidence of disease of internal ear. Disease of cochlea produces deafness to certain tones. This symptom, however, as well as "double hearing" (hearing last notes repeated or echoed) may be secondary to disease of middle ear causing pressure on labyrinth.

Treatment: each case must be treated according to its symptoms. In acute inflammatory disease, cold applications to head, leeches, counter-irritation and avoidance of quinine would be indicated. Effusions due

to syphilis, except in first stages, are less amenable to treatment than any other secondary venereal disease. Chronic affections of labyrinth are hopeless thus far. Electricity, strychnia, etc., have accomplished nothing.

DEAF-MUTEISM.

Is not a primary affection, but merely a condition secondary to disease or congenital defect of the auditory apparatus. Only reason that deaf persons become mutes is that affection of ear is present at birth, or so shortly after that its victim is unable to hear and imitate speech. Deaf-mutes thus fall into two classes: (1) The congenital; and (2) the acquired. Probably the latter class is fully as large as the former. It does not require absolute deafness in a young child to produce deaf-muteism. A chronic aural catarrh that would only inconvenience an adult, may make an infant so stupid that it will soon cease to attempt to imitate speech.

OTALGIA,

or *pain in the ear*, is very rare as a primary affection. It may occur from malaria, syphilis, or a carious tooth.

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GLOSSARY.

The definitions of the words given below can be found by means of the page-references.

Amaurosis. Gr. αμαυροω, *to render obscure*, p. 129.

Amblyopia. Gr. αμβλυς, *dull*, and οψις, *vision*, p. 129.

Ametropia. Gr. α, *privative;* μετρον, *measure;* οψις, *vision*, p. 150.

Ampulla. Lat. *ampulla, a flask*, p. 181.

Anchyloblepharon. Gr. αγκυλωσις, *a stiffening*, and βλεφαρον, *eyelid*, p. 85.

Annulus tympanicus. Lat. *annulus, a ring*, and *tympanicus, tympanic*, p. 167.

Anopsia. Gr. ανα, *without*, and οψις, *vision*, p. 129.

Antrum. Lat. *antrum, a cave*, p. 177.

Aphakia. Gr. α, *privative*, and φακος, *lens*, p. 156.

Arcus senilis. Lat. *arcus, a bow*, and *senilis, senile*, p. 39.

Asthenopia. Gr. ασθενης, *weak*, and οψις, *vision*, p. 150.

Astigmatism. Gr. α, *privative*, and στιγμα, *a point*, p. 154.

Auricle. Lat. *auricula, the external ear*, p. 164.

Binocular. Lat. *bis, twofold*, and *oculus, eye*, p. 54.

Blennorrhœa. Gr. *βλεννα*, *mucus*, and *ρεω*, *to flow*, p. 80.

Blepharitis. Gr. *βλεφαρον*, *the eyelid;* and *itis*, *denoting inflammation*, p. 141.

Brachymetropia. Gr. *βραχυς*, *short;* *μετρον*, *measure;* *οψις*, *vision*, p. 149.

Buphthalmos. Gr. *βους*, *an ox*, and *οφθαλμος*, *eye*, p. 99.

Canaliculus. Lat. *canaliculus*, *a little channel*, p. 38.

Canthus. Gr. *κανθος*, *the angle of the eye*, p. 33.

Caruncle. Lat. *caruncula*, *a little piece of flesh*, p. 37.

Cerumen. Lat *cerumen*, *wax*, p. 168.

Chalazion. Gr. *χαλαζα*, *hail*, p. 143.

Chemosis. Gr. *χημη*, *a gaping;* or *χυμος*, *liquid* (?), p. 79.

Chiasm. Gr. *χιασμα*, *the letter χ*, p. 5.

Choroid. Gr. *χοριον*, *the chorion*, and *ειδος*, *like*, p. 12.

Cilia. Lat. *cilium*, *an eyelash*, p. 35.

Concha. Gr. *κογχη*, *a concave shell*, p. 165.

Cochlea. Gr. *κοχλος*, *a snail with a spiral shell*, p. 182.

Coloboma. Gr. *κολοβωμα*, *a mutilation*, p. 106.

Conjunctiva. Lat. *conjungere*, *to join together*, p. 34.

Corectopia. Gr. *κορη*, *pupil*, and *εκτοπος*, *out of place*, p. 106.

Coredialysis. Gr. *κορη*, *pupil*, and *διαλυσις*, *a rupture*, p. 101.

Corelysis. Gr. *κορη*, *pupil*, and *λυσις*, *a loosing*, p. 66.

Cornea. Lat. *cornu*, *a horn*, p. 10.
Cyclitis. Gr. κυκλος, *a circle ;* and *itis*, *denoting inflammation*, p. 111.

Dacryoadenitis. Gr. Δακρυον, *a tear ;* αδην, *a gland ;* and *itis*, *denoting inflammation*, p. 148.
Dacryocystitis. Gr. Δακρυον, a *tear ;* κυστις, *a bladder ;* and *itis*, *denoting inflammation*, p. 147.
Dacryops. Gr. Δακρυον, *a tear*, and ωψ, *the eye*, p. 149.
Deorsumvergens. Lat. *deorsum*, *downward*, and *vergo*, *to turn*, p. 135.
Diplopia. Gr. Διπλοος, *double*, and οψις, *vision*, p. 50.
Distichiasis. Gr. Διστιχια, *a double row*, p. 143.

Ectopia. Gr. εκ, *from*, and τοπος, *place*, p. 122.
Ectropion. Gr. εκ, *from*, and τροπη, *a turning*, p. 144.
Emmetropia. Gr. εν, *within ;* μετρον, *measure ;* and οψις, *vision*, p. 149.
Entropion. Gr. εν, *in*, and τροπη, *a turning*, p. 144.
Epicanthus. Gr. επι, *upon*, and κανθος, *angle of the eye*, p. 146.
Epilation. Lat. *ex*, *from*, and *pilus*, *hair*, p. 144.
Epiphora. Gr. επι, *upon*, and φερω, *to bring*, p. 146.
Exophthalmos. Gr. εξ, *out of*, and οφθαλμος, *the eye*, p. 72.

Fenestra. Lat. *fenestra*, *a window*, p. 172.

Fornix. Lat. *fornix, an arch*, p. 34.
Fovea. Lat. *fovea, a small pit*, p. 21.
Fundus. Lat. *fundus, bottom*, p. 7.
Fusca. Lat. *fuscus, dark*, p. 13.

Gerontoxon. Gr. γερων, *an old man*, and τοξον, *a bow*, p. 39.
Glaucoma. Gr. γλαυκος, *green*, p. 130.
Glioma. Gr. γλια, *glue*, p. 117.

Habenula. Lat. *habenula, a little thong*, p. 188.
Hamulus. Lat. *hamulus, a small hook*, p. 184.
Helicotrema. Gr. ἑλισσω, *to twist*, and τρημα, *a* hole, p. 184.
Helix. Gr. ἑλιξ, *something twisted*, p. 165.
Hemeralopia. Gr. ἡμερα, *day*, and οψις, *vision*, p. 113.
Hemiopia. Gr. ἡμι, *half*, and οψις, *vision*, p. 49.
Hippus. Gr. ιππος, *a horse; from twinkling of a man's eyes on horseback* (?), p. 105.
Hordeolum. Lat. *hordeolus, a stye*, p. 142.
Hyaloid. Gr. ὑαλος, *glass*, and ειδος, *like*, p. 24.
Hydrophthalmia. Gr. ὑδωρ, *water*, and οφθαλμος, *eye*, p. 99.
Hypæmia. Gr. ὑπο, *under*, and ἁιμα, *blood*, p. 126.
Hypermetropia. Gr. ὑπερ, *beyond;* μετρον, *measure;* and οψις, *vision*, p. 150.
Hypometropia. Gr. ὑπο, *under;* μετρον, *measure;* οψις, *vision*, p. 149.
Hypopion. Gr. ὑπο, *under*, and πυος, *pus*, p. 126.

Incisuræ. Lat. *incisura, an incision*, p. 167.
Incus. Lat. *incus, an anvil*, p. 173.

Infundibulum. Lat. *infundibulum, a funnel*, p. 183.
Iridectomy. Gr. ιρις, *the iris*, and εκτομη, *a cutting out*, p. 66.
Ideræmia. Gr. ιρις, *the iris*, and ερημος, *wanting*, p. 106.
Iridodesis. Gr. ιρις, *the iris*, and δεω, *to bind*, p. 66.
Iridodonesis. Gr. ιρις, *the iris*, and δονεω, *to tremble*, p. 105.
Iridotomy. Gr. ιρις, *the iris*, and τομη, *a cutting*, p. 66.
Iris. Gr. ιρις, *a rainbow*, p. 16.

Keratitis. Gr. κερας, *cornea;* and *itis, denoting inflammation*, p. 87.
Keratocele. Gr. κερας, *cornea*, and κηλη, *a hernia*, p. 91.
Keratonyxis. Gr. κερας, *cornea*, and νυσσω, *to puncture*, p. 67.

Lachrymation. Lat. *lacryma, a tear*, p. 77.
Lacus. Lat. *lacus, a lake*, p. 33.
Lagophthalmos. Gr. λαγως, *a hare*, and οφθαλμος, *eye*, p. 145.
Leucoma. Gr. λευκος, *white*, p. 95.

Macula lutea. Lat. *macula, a spot*, and *luteus, yellow*, p. 20.
Madarosis. Gr. μαδαρος, *bald*, p. 142.
Malleus. Lat. *malleus, a hammer*, p. 173.
Manubrium. Lat. *manubrium, a handle*, p. 173.
Meatus. Lat. *meatus, a passage*, p. 167.
Metamorphopsia. Gr. μεταμορφοω, *to transform*, and οψις, *vision*, p. 158.

Micropsia. Gr. *μικρος*, *small*, and *οψις*, *vision*, p. 158.
Modiolus. Lat. *modiolus*, *the hub of a wheel*, p. 182.
Mucocele. Gr. *μυκος*, *mucus*, and *κηλη*, *a tumor*, p. 148.
Muscæ volitantes. Lat. *musca*, *a fly*, and *volito*, *to fly about*, p. 124.
Mydriasis. Gr. *μυδος*, *moisture; because increase of fluids causes pupil to dilate* (?), p. 104.
Myopia. Gr. *μυω*, *to close*, and *ωψ*, *eye*, p. 149.
Myosis. Gr. *μυω*, *to close*, p. 105.
Myringitis. Lat. *myringa*, *the drum-head;* and *itis*, *denoting inflammation*, p. 213.

Navicularis. Lat. *navicula*, *a small boat*, p. 165.
Nebula. Lat. *nebula*, *a cloud*, p. 95.
Neonatorum. Gr. *νεος*, *new*, and Lat. *natus*, born, p. 81.
Nictitation. Lat. *nicto*, *to wink*, p. 146.
Nyctalopia. Gr. *νυξ*, *night*, and *οψις*, *vision*, p. 112.
Nystagmus. Gr. *νυσταγμος*, *a nodding*, p. 139.

Onyx. Gr *ονυξ*, finger-nail, p. 91.
Ophthalmoscope. Gr. *οφθαλμος*, *eye*, and *σκοπεω*, *to look*, p. 55.
Ora serrata. Lat. *ora*, *a boundary*, and *serratus*, *serrated*, p. 21.
Ossicula auditus. Lat. *ossiculum*, *a small bone*, and *auditus*, *hearing*, p. 173.
Otalgia. Gr. *ὀυς*, *the ear*, and *αλγος*, *pain*, p. 230.
Othæmatoma. Gr. *ὀυς*, *ear*, and *ἁιμα*, *blood*, p. 204.

Otolith. Gr. ὀυς, *the ear*, and λιθος, *stone*, p. 186.
Otoscope. Gr, ὀυς, *ear*, and σκοπεω, *to look*, p. 197.

Palpebral. Lat. *palpebra*, *eyelid*, p. 33.
Pannus. Lat. *pannus*, *a cloth*, p. 93.
Panophthalmitis. Gr. πας, *all*; οφθαλμος, *eye*; and *itis*, *denoting inflammation*, p. 107.
Papilla. Lat. *papilla*, *a nipple*, p. 33.
Patellaris. Lat. *patella*, *a dish* or *plate*, p. 24.
Pectinatum. Lat. *pectinatus*, *comb-like*, p. 16.
Phakitis. Gr. φακος, *lens*; and *itis*, *denoting inflammation*, p. 118.
Phlyctenule. Gr. φλυκταινα, *a pimple*, p. 83.
Phosphènes. Fr. *phosphène*, p. 158.
Photophobia. Gr. φως, *light*, and φοβος, *dread*, p. 83.
Photopsia. Gr. φως, *light*, and οψις, *vision*, p. 158.
Pinguecula. Lat. *pinguis*, *fat*, p. 85.
Pinna. Lat. *pinna*, *a kind of sea-mussel*, p. 164.
Polycoria. Gr. πολυς, *many*, and κορη, *pupil*, p. 106.
Potatorum. Lat. *potator*, *a drinker*, p. 129.
Presbyopia. Gr. πρεσβυς, *an old man*, and οψις, *vision*, p. 155.
Pterygium. Gr. πτερυγιον, *a little wing*, p. 83.
Ptosis. Gr. πτωσις, *a falling*, p. 145.
Punctum. Lat. *punctum*, *a small hole*, p. 33.

Reticularis. Lat. *rete*, *a net*, p. 191.
Retina. Lat. *rete*, *a net*, p. 18.

Scala. Lat. *scala*, *a stairway*, p. 184.

Scintillans. Lat. *scintilla, a spark*, p. 125.
Sclerectasia. Gr. *σκληρος*, and *εκτασις*, *a stretching out*, p. 108.
Sclerotic. Gr. *σκληρος*, *hard*, p. 8.
Scotomata. Gr. *σκοτος*, *darkness*, p. 49.
Staphyloma. Gr. *σταφυλη*, *a bunch of grapes*, p. 97.
Stauungs papilla. Ger. *stauen*, *to stow*, *to dam*, p. 127.
Stenopæic. Gr. *στενος*, *narrow*, and *οπη*, *a hole*, p. 96.
Stillicidium. Lat. *stillicidium*, *a dripping*, p. 140.
Strabismus. Gr. *στραβιζω*, *to squint*, p. 134.
Stroma. Gr. *στρωμα*, *bedding*, p. 13.
Sulcus. Lat. *sulcus*, *a furrow*, p. 9.
Supercilium. Lat. *supercilium*, *the eyebrow*, p. 32.
Sursumvergens. Lat. *sursum*, *upward*, and *vergo*, *to turn*, p. 135.
Symblepharon. Gr. *συν*, *together*, and *βλεφαρον*, *eyelid*, p. 85.
Synchisis. Gr. *συν*, *together*, and *χυσις*, *a flowing*, p. 125.
Synechia. Gr. *συν*, *together*, and *εχω*, *to hold*, p. 102.

Tapetum. Lat. *tapete*, *a carpet*, p. 17.
Tectorian. Lat. *tectorius*, *covering*, p. 189.
Tinnitus. Lat. *tinnitus*, *a ringing*, p. 208.
Trachoma. Gr. *τραχωμα*, *a roughness*, p. 82.
Tragus. Gr. *τραγος*, *a goat ; because hairs like a goat's beard sometimes grow on this part* (?), p. 165.
Trichiasis. Gr. *τριχιαω*, *to show hairs*, p. 144.
Tylosis. Gr. *τυλος*, *a callus*, p. 142.

Tympanum. Lat. *tympanum, a drum*, p. 171.

Umbo. Lat. *umbo, a boss, as that of a shield*, p. 169.
Unguis. Lat. *unguis, a finger-nail*, p. 91.
Utricle. Lat. *utriculus, a small leathern bottle*, p. 185.
Uvea. Lat. *uva, a bnnch of grapes*, p. 12.

Vitreous. Lat. *vitreum, glass*, p. 24.
Vorticose. Lat. *vorticosus, full of eddies*, p. 14.

Xerophthalmia. Gr. *ξηρος, dry*, and *οφϑαλμος, eye*, p. 84.

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